# The Engineer

LONDON, FRIDAY, MAY 30, 1941.


## PUBLIC NOTICES

### THE CITY OF BIRMINGHAM ELECTRIC SUPPLY DEPARTMENT

**MOTOR-DRIVEN AIR COMPRESSOR, ETC.**

The Electric Supply Committee invites TENDERS from experienced contractors for the SUPPLY, DELIVERY, ERECTION, TESTING and PUTTING TO WORK of :—

A STATIONARY (200 cub. ft. per min.) MOTOR-DRIVEN AIR COMPRESSOR, AIR RECEIVER, INCIDENTAL PIPE WORK, &c., at the Hams Hall "B" Power Station, Lea Marston, Warwickshire.

The general conditions of contract (which include the Corporation's usual Fair Wages and Conditions of Labour Clause), specification and drawings may be obtained upon application to the undersigned, accompanied by a deposit of Two Pounds, which will be returned on receipt, by the appointed time, of a bona-fide Tender not subsequently withdrawn. Cheques must be made payable to "The City of Birmingham Electric Supply Department."

Sealed Tenders, enclosed in the official envelope provided and endorsed for the purpose, must be delivered to the undersigned not later than 10 a.m. on Wednesday, 25th June, 1941, when they will be opened. Tenders not complying with the foregoing will be rejected.

The Committee does not bind itself to accept the lowest or any Tender.

F. FORREST,
Chief Engineer and Manager.

14, Dale End,
Birmingham, 4.
30th May, 1941. 7463

### METROPOLITAN WATER BOARD

**TENDERS FOR THE SUPPLY OF STORES, ETC.**

The Metropolitan Water Board invite TENDERS for the SUPPLY of the undermentioned STORES, &c., for the period of twelve months, commencing 1st August, 1941 :—

Contract No.
2 .. Brushes, Brooms and Handles.
5 .. Cotton Waste, Wipers, Hemp, Rope, &c.
10 .. Lead Pipe and Solder.
13 .. Oilman's Sundries.
14 .. Packings, Rubber Goods, Hose and Belting.
15 .. Paints, Varnishes, Linseed Oil, Turpentine, &c.
24 .. Electric Lamps.

Tenders must be submitted on the official forms, which may be obtained on and after Wednesday, 28th May, 1941, from the Chief Engineer, by personal application at the offices of the Board (Room 171), or upon forwarding a stamped addressed envelope (large).

Applicants should refer to the number of the Tender for which forms are required.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed in the manner indicated in the form of Tender, must be delivered at the offices of the Board (Room 122) not later than Twelve o'clock Noon on Tuesday, 10th June, 1941.

The Board do not bind themselves to accept the lowest or any Tender.

R. P. MORGAN,
Clerk of the Board.

Offices of the Board,
New River Head,
Rosebery Avenue,
London, E.C.1.
23rd May, 1941. 7466

### MIDDLE LEVEL COMMISSIONERS

**ASSISTANT ENGINEER**

Applications are Invited for the POSITION of ASSISTANT ENGINEER to the Middle Level Commissioners for Land Drainage Works. Candidates should be competent draughtsmen and surveyors. Previous experience with a Drainage Board will be an advantage, but is not essential.

The salary will be between £150 and £250 per annum, according to qualifications and experience, with a car or motor cycle allowance.

Applications, stating age, training, qualifications and experience, with copies of testimonials, should be received by the undersigned not later than the 16th June, 1941.

G. McLEOD, M.Sc. (Eng.),
Engineer.

Middle Level Offices,
March, Cambs. 7459

### THE MERSEY DOCKS AND HARBOUR BOARD

**ASSISTANT TO ENGINEER-IN-CHIEF**

The Mersey Docks and Harbour BOARD invite APPLICATIONS for the POSITION of an ASSISTANT to the ENGINEER-IN-CHIEF to the Board. Commencing salary £1000 per annum.

Candidates must be Members of the Institution of Civil Engineers and have had good experience in Dock and Harbour Construction and Maintenance Work.

Applications, stating age (which should not exceed 45 years), qualifications and experience, accompanied by copies of not more than three recent testimonials, to be sent to the undersigned not later than June 30th, 1941.

L. A. P. WARNER,
General Manager and Secretary.

Dock Office, Liverpool.
May 24th, 1941. 7473

### COUNTY BOROUGH OF OLDHAM

**PUBLIC HEALTH COMMITTEE**

For Sale at the Boundary Park General Hospital, Rochdale Road, Oldham, TWO HORIZONTAL MULTI-TUBULAR ECONOMIC BOILERS, by John Thompson (Wolverhampton), Ltd. Length 15ft., diameter 7ft.; re-insurance rate 80 lb. per sq. inch. The boilers are equipped with a complete oil-burning installation by the Wallsend Slipway and Engineering Co., Ltd. The whole of the plant was installed (new) in 1931. Tenders are invited for purchase of plant on site. The contractors must allow for dismantling and removal and must include for any making good which may be required. Further particulars may be obtained on site from the MAINTENANCE OFFICER. 7451


## The Engineer

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## WAR DAMAGE

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MORGAN BROTHERS (PUBLISHERS) LTD.


## PUBLIC NOTICES

### CITY OF SALFORD

**ROYAL TECHNICAL COLLEGE**

**PRINCIPAL : J. C. JONES, B.Sc., A.M.I.C.E., A.M.I. Mech. E.**

Applications are Invited for the POST of HEAD of the MECHANICAL ENGINEERING DEPARTMENT. Candidates should possess a good Honours Degree in Engineering and must have had both teaching and industrial experience. Salary scale £450 to £650 (which includes £50 for additional responsibility in respect of Heating and Ventilating Installation) ; but a candidate with appropriate qualifications and experience may be appointed at a salary of up to £600 per annum inclusive.

Further particulars and form of application (to be returned by 21st June, 1941) may be obtained from the undersigned on receipt of a stamped addressed envelope.

F. A. J. RIVETT,
Director of Education.

Education Office,
Chapel Street,
Salford, 3,
Lancs. 7476

## SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

**IMPORTANT**

**Advertisers in Situations Open Column should make themselves acquainted with the terms of**

**STATUTORY RULES & ORDERS**
**1940 No. 877**
**RESTRICTION ON ENGAGEMENT ORDER**

ADVERTISER 7373.—This is to Inform the gentlemen who responded to this advertisement that the selected CANDIDATES have now been INTERVIEWED. 7461 A

## SITUATIONS OPEN

WANTED, WORKS MANAGER for Engineering Works. Must be thoroughly experienced on equipping and obtaining production on Turret and Capstan Lathes. Preferably with experience of Non-ferrous Foundry. Salary £500, permanency for suitable man. State full particulars and experience.—Address, 7467, The Engineer Office. 7467 A

ADVERTISERS REQUIRE the ASSISTANCE of SEVERAL MACHINERY VALUERS, preferably those familiar with collieries, iron and steel works and all classes of machinery in factories. Liberal payments made to competent men and travelling and hotel expenses when engaged out of London.—Please address, stating terms, 7469, The Engineer Office. 7469 A

ASSISTANT to HEAD of ENGINEERING PURCHASING DEPT. Knowledge of D.E. bookg., costing and familiarity with purchases of materials and the keeping of records. Must be exempt from military service.—Address, 7475, The Engineer Office. 7475 A

COST ACCOUNTANT.—APPLICATIONS are INVITED by a large Steel Foundry and Engineering Works from men who are highly qualified and of exceptional experience, for the POSITION of CHIEF COST ACCOUNTANT. The firm is engaged upon work of great national importance. The position is a permanent one, and will command an attractive remuneration to the right man. Replies, which should be fully informative and indicate present rate of salary, will be treated in strict confidence.—Address, 7446, The Engineer Office. 7446 A

RESIDENT REPRESENTATIVE REQUIRED for Midlands with technical, practical and selling experience of Fans and Air Conditioning Problems. No others need apply. Also similar VACANCY, Yorkshire. Permanency.—Write, stating age, detailed experience, salary £30 monthly, bonus on results, to Box K.213, Willings, 362, Gray's Inn Road, London, W.C.1. 7458 A

STATION SUPERINTENDENT REQUIRED for Diesel Generating Station of 5000 kW. Sound practical and technical training essential, also previous experience of carrying out routine maintenance, complete overhauls of large-size two and four-cycle Diesel engines and handling medium staff. Please write, stating age, when free, and full details of training and career.—Address, P3309, The Engineer Office. P3309 A

THE Post You Are Seeking May Not be Advertised in this Column, but do not lose the Opportunity of Bringing Your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for a cost of Four Lines, 4s.; 1s. for each Additional Line. There is no better way of covering so large a field for such a small charge.

WORKS MANAGER for General Engineering establishment in Nottingham employing about 60 hands ; must have organising ability and full knowledge all classes Machine Tools. State details experience, age, salary.—Address, P3308, The Engineer Office. P3308 A

PLANT DRAUGHTSMAN for Rubber Factory, Tyres and General Rubber Goods. First-class machine equipment designer, preferably with Machine Tool Design experience. State age, salary required and when free.—Apply, MANAGER, Employment Exchange, Bristol, 1. 7465 A

## SITUATIONS WANTED

ASST. ENGINEER REQUIRES POSITION. Age 32 years ; 5½ years' asst. works engineer, 5 years tech. asst. and resident engineer, London consulting engineers, on factory building.—Address, P3286, The Engineer Office. P3286 B

B.SC. ENGINEER (40), Experienced in General engineering design, estimating and sales, also in reinforced concrete construction, mining machinery and conveying of bulk materials, SEEKS RESPONSIBLE POSITION.—Address, P3310, The Engineer Office. P3310 B

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ENGINEER, G.I. Mech. E., Public School and University, 8 years' general practical experience, including plant erection, heavy oil engines, mining plant, aircraft, &c., SEEKS ACTIVE EMPLOYMENT with manufacturers or contractors.—Address, P3316, The Engineer Office. P3316 B


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**CLASSIFIED ADVERTISEMENTS CLOSE FOR**

**PRESS—NOON WEDNESDAYS**

# Further Canadian Locomotive Experiences

By EDWARD H. LIVESAY

No. IV

(*Continued from page 254, April 18th*)

"THE DOMINION" TRANSCONTINENTAL, CANADIAN PACIFIC RAILWAY

CANADA is a country of great distances, which one realises to the full when crossing it by train. The C.P. Transcontinental line begins at Saint John, New Brunswick, on the Atlantic, and extends 3364 miles, *viâ* Montreal, to Vancouver, on the Pacific. The through journey takes twelve hours to Montreal, where one arrives early in the morning. After an intermission of a similar period the pilgrimage is resumed in the evening, and continues for 87 hours 20 minutes, after which, all having gone well, one should be in Vancouver. The grand total is therefore a little over four and a-half days.

It would have been quite possible for me to have covered the entire distance in locomotive cabs, a thing that most likely nobody ever did before, but an inborn reverence for truth compels me to confess failure thus to achieve distinction. My journey turned out to be something like Mark Twain's boasted and much-heralded bicycle ride from Hartford to Springfield. When challenged, he had to admit that he had not actually done it, but, at any rate, he had ridden far enough to demonstrate that it could be done. So with my trip; I did not ride locomotives all the way from Saint John to Vancouver—only far enough to demonstrate that I did not want to. *Cui bono?*

Probably about two-thirds of the distance were covered in this way, with intervals for rest and meditation, all that was necessary; even my interest in locomotives is apt to flag a little after twelve hours or so in the cab at a stretch. Thus I may have missed a journalistic scoop, but I had a much pleasanter experience, and I hope the result will be just as satisfactory to the reader. This account tells what transpired *en route*.

TORONTO TO FORT WILLIAM

Train No. 3, "The Dominion," begins its journey to the West in two sections, which leave Montreal and Toronto respectively in the evening, meeting and making common cause early next morning at Sudbury. I joined the Toronto part, finding the engine to be "No. 2839," with Engineer Ward and Fireman Grimwood. This class (Fig. 14) has been described before in these articles (March 17th, 1939, and October 25th, 1940), so I need only remind the reader that they are 4–6–4 "Hudsons" with 6ft. 3in. drivers, cylinders 22in. by 30in., 5501 square feet of heating surface, an 81 square feet grate and steam pressure 275 lb. "No. 2839" is booster equipped, which brings the tractive power up to 57,000 lb. These very fine engines now handle the trains right through from Montreal to Vancouver, except for the mountain section of 262 miles between Calgary and Revelstoke, which is worked by the large 2–10–4s of the "5900" class, as will be described in due course. The original "5900s" were dealt with in the March 10th, 1939, ENGINEER; it is the new "5920" class that comes into the present account.

Fig. 15 shows several of the cab fittings that have been referred to in these articles and applies to this class of engine. The serrated reverse wheel A is turned by hand, but air power does the work, controlled by handle B. The gear is locked in the required position by the trigger C. D is the hanging throttle lever, working fore and aft; a multiple throttle is used. The brake handle is at E. The engineer's dials are the Ashcroft exhaust pressure and two brake gauges. F marks the Franklin divided fire-door, air operated by the treadle G, even though mechanical stoking is used, and the door is very seldom opened. The lever T opens the door by hand if required, and also holds it open. H is the upper part of the coal elevator. The stubs S S work the six sections of the rocking grate, a detachable lever fitting on to them. V marks the five valves of the steam jets, blowing the fuel into the four corners and centre of the fire-box; the fireman's gauges concern steam pressure, booster, feed heater, steam heat, superheater and stoker engine. It is a thoroughly well-arranged cab, with convenient controls, in which the crew's comfort is considered; ventilation is good; it can be both cool in summer and warm in winter's 50 below zero frigidity. Also it is clean—unless the coal is very dusty—and I cannot find fault with anything. So it must be all right!

"The Dominion" pulled out of the Union Station, Toronto, at 10.55 p.m., the load being thirteen cars—say, 1000 tons. The booster, which had been ticking over in neutral to warm up, was cut in at the start; with its assistance acceleration was good; it went out of action at about 12 m.p.h. Suburban stops at Parkdale and West Toronto disposed of, the city's widespread lights became scattered and disappeared, the train entering a non-stop stretch of 45 miles to Alliston, over single track, with considerable gradients and curvature. There seemed to be a steady rise to Bolton, 26 miles, but the engine made light work of it; the riding was good and the motion free from any of the knocks and pounds that for me go far to spoil an otherwise pleasant run. "No. 2839" was evidently in good shape, which augured well at this, the start of my long Transcontinental trip. The vestibule cab, with its shaded lamp in the roof, throwing pencils of light on to the various gauges; the comfortable deeply padded seat behind the fireman—no orange box or block of wood this time!—the friendly attitude of the crew; I had no complaint to make on any score. Except perhaps that it was night and darkness covered the earth, as well as many things I wanted to keep an eye on. I am not very enamoured of night riding; one misses things; the warmth and "dim religious light" in the cab contrasting with occasional dazzling rays from chinks in and about the fire-door; the rumble and vibration; all these make for drowsiness, and so it was on this occasion. For a while I fought it, concentrating on my notebook, but in the wee sma' hours I gave up the struggle and retired to the train. "I'll come back at MacTier, the next divisional point—don't shove off without me." But we all broke our promises; waking, the train was passing Romford, approaching Sudbury, 260 miles from Toronto, coming to a stand there at 6.15 a.m., having covered the distance in 7 hours 20 min., with nine booked stops and probably one or two others at crossing places, so the average speed of 35 m.p.h. is better than it sounds. It had been over single track, through increasingly difficult country, particularly in the Muskoka Lakes district, with a by no means negligible load of 1000 tons.

Sudbury is the centre of Canada's nickel industry and a junction point. The Montreal section of "The Dominion," five cars, which had come *viâ* Ottawa, was added to our train here, bringing the load up to about 1350 tons. We were on the threshold of the primitive north country beyond Lake Huron, and very stern it looks. Winters are hard up here; for instance, the town of Iroquois Falls is not far off, where in 1935 Canada's all-time low temperature record was made, 78 deg. below zero—110 deg. of frost. Locomotive work is difficult under such conditions; efficiency is reduced by the necessity of heating incoming air up to combustion temperature, and radiation is excessive; metal becomes brittle and may fracture; the tender water has to be warmed, and exposed pipes and cocks freeze up. Yes, this north country both looks stern and is stern; man and machine alike have to fight it, and woe betide them if they fail. But this was spring, and potential severity was hidden under a mask of green. It was hard to picture the landscape as it had been only a month or two before.

"The Dominion" left at 6.55 a.m., with Engineer Berry and Fireman Rousselle in the cab and a "pusher" engine ahead. Hibernian, but American, too. It is double track here, but there is a heavy gradient to Cartier, 35 miles, the rise being 521ft., too much even for a booster-equipped "2800" single-handed. Talking about the mechanical stoker, Berry pointed out that in regulating the feed allowance should be made for the weight of the coal, whether it is coarse or fine, wet or dry, and the controls set accordingly. At my request he showed me the effect of cut-off variation on exhaust pressure, as indicated by the Ashcroft gauge. With maximum travel the exhaust pressure went up to 15 lb., whereas it was only about 5 lb. with 25 per cent. Throttle position did not seem to have much effect—scarcely any, in fact. As two engines were on the train the work was quite easy for both; there was no stop before Cartier, reached at 8 a.m., average speed 32 m.p.h. Here the pusher came off and the double track from Romford ended; the crew changed, Messrs. Kelly and Portelance taking over. The same stern wilderness of rock, stunted fir and birch continued; we passed innumerable icy lakes and fields of muskeg (Anglice, peat bog—Stephenson had a name for it; he had to master it at Chat Moss, doing so by the same method as is followed to this day; a mat of logs and brush sunk by spoil dumped on top until it will sink no farther). It is wild and primitive country up here; I kept an eye lifting for moose, but saw none. Save for the absence of hills, it reminded me of the West Highlands, and the Mallaig line, and parts of the L.M.S. over Drumochter to Inverness. But I would exchange 100 square miles of this Northern Ontario waste for a fragment of Bonnie Scotland—and even then I should have the best of the deal.

On this run, as usual, the crews were friendliness personified; but then they always are. They seem glad to have an observer with them, so long as he is interested—and fairly intelligent. I do claim to be the former. A little tact is useful on occasion. When one is given an obvious piece of misinformation, which can happen, don't argue—"lie low and say nuffin'." It works! All "train orders" were shown to me as they came from the conductor (guard): "Bad spot in track 5 poles short of 20+20," "Train No. 13 annulled," and so on. Along here signals were only to be seen at stations, where they remain at "Clear" unless a stop is called for. Train handling under these conditions is simple, very different from the unceasing vigilance imposed upon the enginemen in England

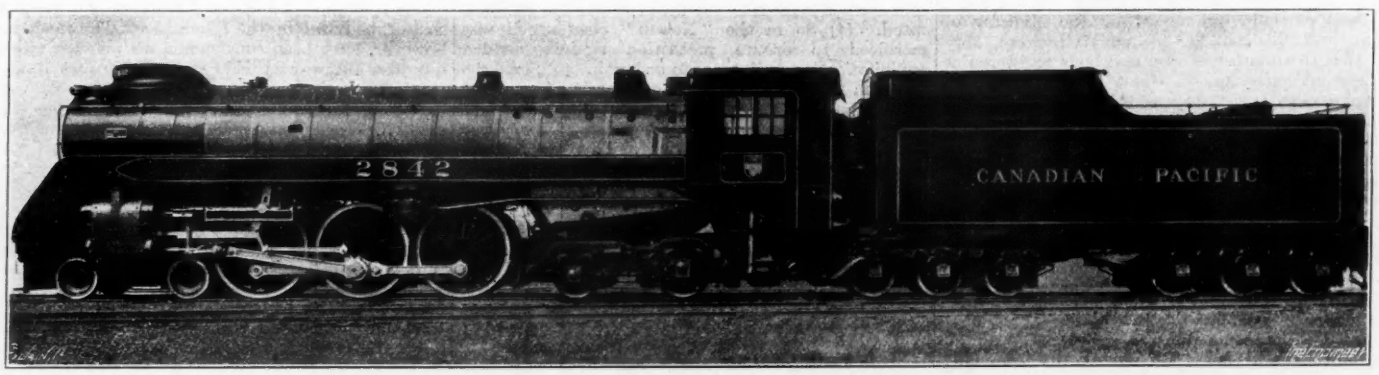


FIG. 14—C.P.R. EXPRESS LOCOMOTIVE "2800" CLASS

by the multiplicity of signals, many junctions and heavy traffic, with train following train at close intervals, and high speed. In "2839's" cab there was a feeling of ease and absence of strain; the engineer had few signals to watch for, the fireman no shovel. We could all sit in comfortable seats, chat, enjoy the outlook and watch for moose or what have you. There was nothing to worry about and "The Dominion" rumbled along at a steady 40–45 m.p.h., care forgetting, by all care forgot. No need here for the concentration I remember in the cabs of "The Coronation Scot" or "Flying Scotsman"—not that there was anything actually nerve-racking there either, with "top link" men in charge; but there certainly was a singleness of purpose, an eternal vigilance, absent from "The Dominion." Nobody was looking for moose, anyway! Don't get the wrong idea, though; I am not suggesting there was any slackness in "No. 2839's" cab, only that conditions did not call for the keen application essential in England; but it was no doubt in reserve, ready at a moment's notice for emergencies.

Chapleau was the next divisional point, 136 miles from Cartier; there had been one stop *en route*; the time and speed had been 205 minutes and 40 m.p.h. respectively. Away at 11.45 for White River, reputed to be the coldest place in Canada, but I doubt it—think of Iroquois Falls' 110 deg. of frost; there could not very well be any place colder outside Siberia. It also is a divisional point, 130 miles from Chapleau; time, with two stops, 230 minutes 34 m.p.h. In North America crews only make runs of 100–150 miles. Such trips as London-Plymouth, 226; London-Carlisle, 299, and others round about 200 are unknown on this side of the Atlantic.

White River was left at 3.45 p.m., the proximity of Lake Superior being indicated by a sudden drop in temperature, from almost sultry heat to delicious coolness. Soon the blue waters of the great inland sea, shining in the sun, came in sight at Heron Bay, and the train began to follow along the indented shore, round bays, through little tunnels piercing shoulders of rock, none of them being more than a few yards long. At Peninsular another pusher came on to help up the long gradient from Jackfish to Schrieber, 360ft. in 20 miles. The scenery is fine here and curvature is so incessant that, in spite of the two engines, some slipping occurred. The booster could give no assistance, as it can only be cut in at starting, at speeds up to 12 m.p.h. On this difficult section the stoker seized a chance to go out of action, some big lumps of coal jamming in the opening to the conveyor. Before it was cleared the steam had fallen to 225 lb.; with continuous mechanical feeding the fire is fairly thin and fire-box temperature soon drops when the feed ceases. The obstruction cleared, in a few minutes the needle was near blowing-off point again, a good example of the benefit of mechanical stoking coupled with a large grate and ample heating surface.

Schrieber was reached at 7 p.m., 110 miles in 195 min., 35 m.p.h., and we left again, minus the pusher, at 7.10, on the last lap to Fort William, where I intended to stop off. I was getting sleepy again, too; twelve hours in the cab takes it out of one, so I retired to the train, to woo tired Nature's sweet restorer. She accepted my advances so readily that had not a friend, failing to find me in the cab at Fort William, sought me in the train, I should have been carried on to Winnipeg and points west. "The Dominion," I was told, had arrived at 10.45 p.m., O.T., after averaging 37 m.p.h. from Schrieber. The 811 miles from Toronto had imposed plenty of heavy work, the load over most of the distance having been 1350 tons. Gradients and curvature had been frequent so the time taken, 24 h. less 10 min., and an overall speed of 34 m.p.h., had been very creditable. I like the "2800" class very much. It comes into the same category of my locomotive affections as Mr. Stanier's "Coronations"—"and I can't say no fairer nor that." They are efficient, powerful, and fast, and their riding is excellent.

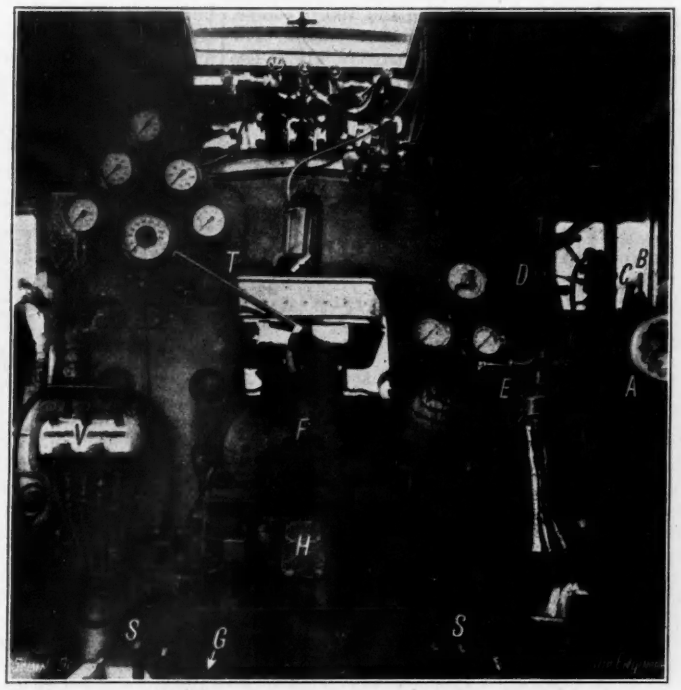


FIG. 15—CAB OF THE "2800" CLASS

### FORT WILLIAM TO WINNIPEG

The twin cities of Fort William and Port Arthur are products of the flood of wheat that pours through them every year, most of it going out in great "tankers," *viâ* Lakes Superior, Huron, Erie, and Ontario, for the St. Lawrence and Atlantic. There is double track out of Fort William to Winnipeg, and some distance beyond. I left with "The Dominion" as before, the second section after having mistakenly boarded the first, and been yanked out of it. I had settled down comfortably in my seat, and we were all getting acquainted when an official climbed into the cab. "Say, Mr. Livesay, this section's no good to you! It's only got six cars on—baggage and sleepers. You want to take the second section, the heavy one, if you're looking for locomotive work." So down I got, waving good-bye to the party of the first part, to wait the arrival of the party of the second. This turned out to be no less a machine than "No. 2850," the Royal train engine, that had taken Their Majesties across Canada in 1939. I should like to say that it had been put on specially to take me, too, but once again Truth forbids—it was chance, not significance that had led to this good fortune. The cab of this famous engine naturally took on a glamour I have never before felt on any other locomotive, which was intensified when Fireman Miller told me that His Majesty had ridden some distance in my seat—sorry; I mean the other way round. It was a proud moment. For the first time in my life I was sitting in one of the seats of the mighty; it will probably be the last. This regal cab seemed much the same as other more plebeian examples I have occupied on the same class of engine, but I did notice one or two little refinements, such as stainless steel sheeting, neatly capped wash-out plugs, and seats rather better finished than usual. All these little things had a cumulative effect, no doubt, making me see visions and dream dreams. When I addressed a remark to Engineer Robertson, it felt as though I were making a Speech from the Throne.

"The Dominion" was double-headed out of Fort William, owing to a heavy rise of 967ft. in the 53 miles to Raith so a "Pacific" lent its assistance. We got away in good style, with a load of 1000 tons, thirteen cars, and were soon running at 60 m.p.h. through a night black as a pocket, the darkness being split every now and then by vivid flashes of lightning, the aftermath of a storm that had deluged Fort William earlier in the day. When two engines are on, the crew of the train one has a peaceful time, most of the responsibility devolving on the leader. The colour-light signals showed up well and the action of "No. 2850" was exceptionally good. It was evidently in first-class shape, as also was the track. The first stop was at Raith, 12.03 a.m., for coal and water, and to drop the pusher; 53 miles of heavy going in 96 min., 33 m.p.h. Getting away at 12.13 on a falling gradient, the speed rose rapidly. I noticed the grate was rocked more than once—see Fig. 15 for the means employed. Rocking grates are certainly needed with North American coal, which seems inclined to cake, though they may not be in England. During my 392 miles non-stop runs with "The Flying Scotsman," and 402 miles with the "Coronation Scot," for instance, they were never needed; not even fire-irons were used, in my recollection. But the coal was very different from the Canadian variety. Welsh coal, on the other hand, as used on the Great Western, seemed more apt to clinker.

Ignace was reached at 2.05 a.m., 94 miles in 112 min., at a considerably higher speed—in fact, so much higher that I am not sure we ever did it! It looks a bit fishy. The crew changed, and I went back to the train for some sleep, returning to the engine at Kenora, the next divisional point, the arrival time being 5.32 a.m.; 140 miles, with one stop, in 212 min., 41 m.p.h. I found the ground crew at work as usual, greasing, ash-pan cleaning, and so on. This comparatively frequent attention must be due to grease lubrication. Referring again to long British runs, "The Flying Scotsman" does its 392 non-stop miles without examination *en route*, and similarly the various "Scots," their 402 miles between London and Glasgow, and I can remember nothing of importance being done or needed until the runs were over.

"The Dominion" left just before sunrise; the air was deliciously cool and fresh, and it was very pleasant to run through this virgin country of fir, rock, and lake, untouched by the hand of man, save for the railway cutting its trail to the west. Everything was dew-soaked, glistening in the rays of the newly risen sun. No wonder a lonely siding along here had been chosen one night as a resting-place for Their Majesties. It was pointed out to me. At Whitemouth there was a stop for water, and here the rock outcrops were left behind, the track lay straight and level, bordered by wheat-fields, instead of muskeg, lake, and forest. We had reached the prairie at last; that great granary of the Empire, extending for nearly 900 miles to the foothills of the Rockies. The train had followed the left-hand metals from Fort William, actually the original single track, but at Molson it crossed to the right by a fly-over. The other line is a more recent one, used by eastbound traffic, particularly the heavy wheat trains to Fort William, the gradients being easier than those of the older line.

Shortly after, the jagged outline of Winnipeg's high buildings showed up ahead, sprawled across the skyline. The bell began to toll as the train picked its way cautiously through the suburbs into the depôt, coming to a stand at 9.20 a.m., having covered the 126 miles from Kenora in 3 h. 10 min., including three stops, at an average speed of 40 m.p.h.

### WINNIPEG TO CALGARY

Winnipeg roughly marks the half-way point on "The Dominion's" transcontinental journey from Montreal to Vancouver. It is 1409 miles from the former city and 1473 miles from the latter. It is the gateway to the prairie, with a population of 275,000, a big railway centre, and a bottleneck through which traffic pours in both directions across Canada. The succeeding 832 prairie miles to Calgary serve as a sort of "rest and be thankful" between the heavy eastern divisions and the even heavier British Columbian mountain section. I must give this a somewhat more rapid survey, as it was partly covered in THE ENGINEER of March 10th and 17th, 1939, though my passage was then in the opposite direction, and not entirely over the main line. Broadly speaking, there is a steady rise of 2672ft. over the 832 miles to Calgary, though short lengths of heavier gradients do intrude in places; curvature is almost non-existent. If you have long sight, and revel in great open spaces and immense vistas of limitless distance, sunshine and blue sky—and 50 below in the winter, which lasts six months—you will love the prairie. If you do not, but crave variety, hills, streams, trees, flowers, a Devon climate, and the Pacific's great rollers thundering on sandy beaches and rocky cliffs, you will hurry through the prairie as fast as the Deuce and "The Dominion" will let you, never pausing until you reach the Rockies and British Columbia—which is what I am going to do now. I do not

altogether dislike the prairie, and I like and admire prairie people—some of them, that is—but I do not want to live there any more. Like the old grey mare, "it ain't what it used to be." Compared with B.C.—well, I ask you!

"The Dominion" left Winnipeg at 10 a.m., headed by engine "No. 2844," of the same class as before, save that it was minus a booster. Messrs. Webb and Kneller were in the cab, the day was warm and sunny, and the spreading plain looked its best. The young wheat, the prairie's *raison d'être*, was just coming through the black soil, making a green carpet as far as the eye could reach. The load was about 1100 tons, rather lighter than usual, Webb said, and the train was still in two sections. At once I noticed the prairie alkali water getting in its deadly work, as two special blow-down cocks had to be opened every 10–15 miles. They take the sludge from near the throat plate—I suppose close to the foundation ring—and the smoke-box end of the barrel. This alkali water is beastly stuff, upsetting boilers as badly as it upsets me, in the first case causing scale formation and foaming, and in the second—but let us pass on to pleasanter subjects. My notes say: "Why not continuous blow-down?" I noticed this in use on several types of L.M.S. engines, including the "Coronations."

The speed was a steady 65 m.p.h. over double track in good condition as far as Virden. The permissible prairie limit is, I believe, 75. Brandon and Broadview were divisional points, where crews changed. At the latter place Time changed, too, watches being put back an hour. This makes the time-table a little confusing unless you are wise to the trick, as the train appears to be booked out 45 min. before it gets in.

The cab was noisier than usual, all the doors, windows and ventilators being open, and the engine working fairly hard on a continuous gentle up-gradient. Talking above the roar was rather tiring, made none the less so by the whistle, which is sounded at all the innumerable level crossings—two longs, a short and a long. A perverse Fate always seemed to call for its long-drawn-out, raucous bellow just when I wanted to say something in a hurry; or, worse still, just after I had begun, and felt disinclined to stop. These ill-timed and blatant interruptions often vexed me into making remarks that certainly I had never intended, and that in calmer moments I came to regret. They will not be found in the Book of Common Prayer. But the law ordains that the warning be sounded at all crossings, and wisely; there are still quite a number of people outside asylums who are sure the train has passed because they can see its tracks.

Between Sintaluta and Indian Head, nearing Regina, the speed was over 75 m.p.h., the theoretical limit. It was only my estimate; there was no indicator on the engine. At this rate of travel the riding was good; not exactly diesel-electric (see THE ENGINEER, September 27th, 1940), but it might have been a whole lot worse. This sounds rather like damning it with faint praise; let me put it this way, then. I was forced to the conclusion that certain heavy pieces of machinery were moving to and fro rapidly, that our wheels were running on rails, and that the latter had not been put down with a spirit level. That's better. In any case, "No. 2844" treated me far more gently than that other apparently springless prairie engine (THE ENGINEER, March 10th, 1939), from which, in desperation, I was forced to desert at Wilkie. Thinking over that experience, I feel that in justice to myself, "desert" is hardly the proper word to use. I was in the same predicament as Rastus, reprimanded by the judge for deserting his wife. "Jedge, ef yo' knowed dat woman lak Ah does, yo' wouldn't call me no deserter. Ah's a refugee." So was I.

Double track appeared again at Indian Head, extending to Swift Current. Over this stretch a representative of a water treating concern was in the cab, taking samples of the boiler content, which in a moment of enthusiasm he referred to as water. To me it looked more like soup. My companion said that actually it was not too bad; then all I can say is that boiler has my deepest sympathy. This reminds me; no dome was fitted to "No. 2844," nor are they to be found on any of the latest C.P.R. engines, except those working in the mountains, where severe gradients alter the water level considerably and can cause water to be carried over into the cylinders. Mr. Bowen, the C.M.E., explained that the necessary cutting of the boiler for a dome weakens it, and when the former is of large diameter and high pitched, only such an exiguous dome is possible that it is scarcely worth while, a collector dry pipe being a preferable substitute. Shallow domes are of little value except as a housing for the throttle, and here again, when the multiple type is used, placed in the smoke-box, as on the "2800" class, even that excuse is lacking; the dome is probably more ornamental than useful.

Regina, though the capital of Saskatchewan and a great railway centre, is not a divisional point, the next one being at Moose Jaw, followed by one at Medicine Hat. This is where the natural gas comes from, and the street lamps are kept burning all day; it is cheaper to do this than to pay people to put them out. All these divisional points are about 125 miles apart; they allow of engine servicing, the changing of crews, and so on. It will have been noticed that though the crews do not make long runs the engines do. There was only one change of engine between Toronto and Calgary—unless "No. 2850" came on at Fort William, to make the run to Winnipeg; I am not sure about this. But even so, it does not affect my point, as "2844" was making the 832 miles from Winnipeg to Calgary in her stride.

At Moose Jaw, 7.10 p.m., it began to get dark, and as I had been in the cab ever since leaving Kenora, nearly fourteen hours, I decided to call it a day, and went back to the train *viâ* the baggage car, its friendly attendant cooking me a most welcome dish of bacon and eggs *en route*. There is a camaraderie among railway men in Canada and the States, and an informality about these locomotive experiences that make them correspondingly pleasant. So it was in England, too, of course, though perhaps not quite to the same extent. For instance, I cannot imagine the guard of, say, "The Coronation Scot" slapping a dish of bacon and eggs down in front of me, saying "There you are—get outside that!" I don't say the will would not be there, but the means and time would be lacking—and the bacon and eggs, too, in all probability.

Returning to the world of locomotives and duty at 6 a.m. next morning, I found we were standing at Gleichen, and I stepped down on to the track in a "nipping and an eager air," as exhilarating as champagne, and almost as sparkling. A few stars were still glittering, but their ineffectual fires were paling before the dawn light strengthening behind us in the east. As I walked along beside the train I looked ahead of the engine; what was that jagged outline stretching all across the western horizon? The Rockies! Yes, there they were, just as I had so often pictured them in the nostalgia induced by a long spell of London's murk; a notched and piled up battlement, sharp-toothed, but gloriously beautiful; a massive grey-white wall barring the way into British Columbia. The countless snowy peaks were already turning rose-pink as the sun, still hidden from us down there on the plain, flung its invisible rays far overhead to light up the mountain tips a hundred miles away. During those happy Scottish locomotive experiences of mine, when first I saw Rannoch, Ben Nevis and Drumochter, I remember my thoughts going back again and again to the Rockies, and I had felt sure that some day I must and should see them again. To-morrow the dream would come true.

"The Dominion" came to a stand in Calgary at 7.50 a.m.; I stopped off for twenty-four hours to rest, go over my notes—and have a bath. Across the prairie the engines burn coal and raise the dusty ballast, whereas over the next stretch oil-burners operate, and the track is rock ballasted and oiled, too. The 832 miles from Winnipeg, during which the train had climbed from 766ft. to an altitude of 3438, had been covered in 21 hours 50 min., which included about thirty stops, making the average speed 30 m.p.h.

*(To be continued)*

# The Coming Crisis in Electrical Power Transmission

By H. RISSIK, Hons. B.Sc. (Eng.), A.M.I.E.E., M. Amer. I.E.E.

No. I

"MANKIND always sets itself only such problems as it can solve. For, when we look closer, we shall always find that the problem itself only arises when the material conditions for its solution are already present, or at least coming into being." This observation of a nineteenth-century revolutionary philosopher, although made in an era when all change was thought of in terms of an unlimited process of improvement along lines already well established, looked forward to the time when the rather smug and self-righteous concept of Victorian progress would be no longer applicable. Few, I think, will deny that this time is now upon us; that we are living, in fact, in an age of revolutionary upheaval embracing the whole complex of human achievement and endeavour—technology, science, economics, politics, sociology, art, philosophy and religion. The struggle to-day is for the supreme prize, mankind's very way of life, and it is being carried on between those who are committed to what Dr. Rauschning has termed the "revolution of destruction" and those who favour a corresponding "revolution of construction." Moreover, the weapons of this revolutionary struggle—the tank, the bomber and the submarine—are the bitter fruits of science and technology, which, no less than the sweeter fruits that lie within the grasp of a peaceful and ordered civilisation, depend for their nurture on electrical power. For the scale of material production is becoming so vast that the arts of war and peace alike can no longer be carried on without the means of harnessing to an ever-increasing extent the world's virtually inexhaustible sources of electrical energy.

Under these circumstances we must sooner or later reach a crisis in the sphere of power transmission. The existence of electrical means for transporting power cheaply and conveniently over considerable distances has at last done away with that hideous and, from the standpoint of national health, ruinous necessity of the nineteenth century—the aggregation of large industrial populations in cramped areas coterminous with fields of coal or lignite. The rationally planned society to which we look forward in the coming years will inevitably seize upon such an advantage to locate its centres of production in regions selected, not for the narrow reason of a primitive economic necessity, but from broad considerations of human welfare. In so far as potential areas of power utilisation are thus emancipated from the bonds which have hitherto tied them so closely to corresponding areas of power production, the exploitation of natural wealth is no longer subject to geographical restrictions. The Tropics of the Old and New Worlds, the savannah lands of Asia, Africa and South America, the vast mineral regions of China and Siberia, all are as yet undeveloped and unpopulated. Yet before these almost virgin areas can be opened up and their resources brought into the service of mankind, the world's sources of cheap water power (Fig. 1) would have to be harnessed and linked up.

Is an undertaking of this nature an immediate technical possibility or does it pertain to the realm of Wellsian phantasy? What are the immediate prospects of being able to utilise immense and inexhaustible reservoirs of dormant electrical energy, such as the Norwegian fjords, the waters of the St. Lawrence and the Mississippi or of the Niger and Congo in Central Africa, the high falls of the rivers on the borders of Brazil and the Guianas, the upper cataracts of the Nile, or the canyons of Himalaya and Tibet? What precisely are the issues involved in transmitting power electrically over enormous distances, of the order of thousands rather than hundreds of miles? The problem here is a fundamental one. It is no longer just a question of continuous advance in the direction of greater transmitted powers and increased transmission distances on the basis of an existing technique. Rather is it a matter of fresh concepts, of a revolutionary outlook on the electro-technical basis of power transmission. As is the case in many other spheres of human activity to-day, there is here no hope of further development along well-established lines. In fact, there is evidence that the crisis in the sphere of electrical power transmission is upon us as soon as we begin to think beyond our present achievements.

## THE HISTORIC "BATTLE OF THE SYSTEMS"

Although Faraday's discovery, over a century ago, of the principle of electro-magnetic induction

marks the starting point in the evolution of electricity as a new form of power generated by mechanical effort, the creation of an electricity supply industry had perforce to await the discovery by Siemens, thirty-five years later, of the dynamo-electric principle and its application to the self-excitation of electrical generators. By that time the accumulator or secondary battery had become well established as a convenient, albeit limited, means of storing electrical energy in the D.C. form, so that the generation and utilisation of electrical power, mainly for purposes of illumination, inevitably developed on the D.C. system. A multiplicity of private and municipal "lighting stations" came to be erected, containing a number of D.C. generators in parallel with large batteries of accumulators floating across the station bus-bars so as to ensure the most efficient utilisation of the generating plant. As time went on, however, and attention came to be directed towards the supply of electricity to urban districts and beyond, the limitations imposed by low generation voltages, coupled with the inability to effect voltage transformation, led to a growing realisation of the unsuitability of the D.C. system for electrical power transmission, a realisation which culminated in the historic "battle of the systems" in the 'eighties of last century.

The protagonists of the A.C. system were at first handicapped by the fact that A.C. could only be utilised in the single-phase form. Although the single-phase synchronous motor, originally suggested by Wilde in 1869, had been developed commercially, it could never compete with the D.C. motor. The situation was eventually saved by Ferraris, who showed in 1885 that two alternating currents of different phase could give rise to a rotating magnetic field, a revolutionary principle which was successfully embodied in Tesla's

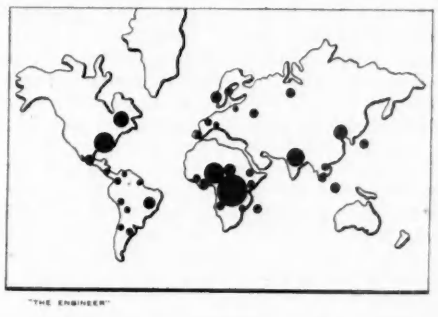


FIG. 1—WORLD SOURCES OF WATER POWER

two-phase asynchronous motor a few years later. It was not until 1890, however, when the prototype of the modern three-phase induction motor was developed, that the A.C. system of power transmission began to make headway against the earlier D.C. system. By the turn of the century the victory had gone to the A.C. system, for it had solved the hitherto formidable problem of utilisation—a sphere in which the D.C. system can maintain a prominent place even to this day. But the latter system failed to solve the vital problem of transmission, since it inherently lacked the wherewithal to step up the voltage to an economic value, and was therefore doomed from the start.

Notwithstanding its defeat in the furious battle that raged in the last two decades of the nineteenth century, a defeat which was made certain by the success of Ferranti's A.C. generating station at Deptford, the D.C. system of power transmission remains the ideal. Thury's 125-kV constant-current system of D.C. transmission, still operating to-day over some 300 miles between Moutiers and Lyons, is a standing acknowledgment of that fact. The great Kelvin declared thirty-five years ago that he had "never swerved from the opinion that the right system for long-distance transmission of power by electricity is the direct-current system." When the Victoria Falls Power Company was first formed and it was proposed to transmit power to the Rand, some 700 miles to the south, he stoutly and stubbornly upheld the claims of D.C. for this purpose. Kelvin's opinions were apparently sustained by a conversation he had had with Lord Rayleigh, when the "battle of the systems" was developing, in the 'eighties of last century. During the course of that conversation Lord Rayleigh said that he rejoiced to see A.C. coming in "because the whole world will now learn the subtleties of electrical science . . . and after that they will come back to continuous current." In the sphere of power transmission, at any rate, there are not lacking signs that Lord Rayleigh's prophecy may yet be fulfilled. Many believe that the historic defeat of the D.C. system was not final, but that in the near future the vanquished may enter the field of battle once more and this time emerge the ultimate victor. The D.C. system has all the theoretical advantages; it lacks only the modern weapons with which to resume the struggle. But so, for that matter, does its opponent, firmly entrenched, after forty years of peace.

### THE DEVELOPMENT OF ELECTRICAL TRANSMISSION

The rapid and widespread development of power transmission on the three-phase A.C. system is a direct consequence of Jablochkoff's transformer, Tesla's induction motor, and Parsons' steam turbine. The first invention made possible the stepping up of the generated voltage to levels dictated by purely economic considerations. To keep the transmission loss within reasonable limits the transmission pressure must increase with distance, the time-honoured relation between the two being one kilovolt per mile. As the most up-to-date example of this practical rule may be cited the 287-kV transmission line between Boulder dam and Los Angeles, which has a length of some 275 miles and went into commercial service early in 1937. The transformer also, of course, makes possible the stepping down of these necessarily high transmission pressures to the normally low voltages of A.C. utilisation. It is here that the second invention has proved of inestimable benefit to the growth of the electricity supply industry. It is no exaggeration to say that, with the exception of transport, modern technology—steel, coal, textiles, chemicals, manufacture and even agriculture—owes more to the induction motor than to any other single tool. Without the simple electric drive which the advent of the induction motor introduced, industry as a whole could have made but little progress. The third invention finally placed the generation of electricity on a secure economic footing. The steam turbine, when direct coupled to a high-speed alternator, constitutes the most efficient, compact and powerful electric generating unit which it is possible to conceive. Its advent made possible the economic generation of large blocks of electric power in relatively few favourably situated generating stations, and thus did away with the uneconomic generation of small powers at sites of immediate consumption. In this way the ground was prepared for the next major phase in the development of the electricity supply industry, the creation of individual power systems by the linking up of scattered load areas through distribution networks fed from one or two large generating stations.

Although the initial impetus towards the interconnection of generating stations so as to form, with their appended distribution networks, a composite power system, no doubt derived from economic considerations, the technical advantages of interconnection have been equally important to its continued development. Apart from the obvious and immediate advantage of reduced generation cost, resulting from the concentration of several large and thus efficient generating units in one station at the centre of gravity of each widespread load area, the interconnection of such stations reduces the amount of reserve plant required in the power system as a whole and, in addition, it improves the load factor and operating efficiency of the system. Alongside these economic advantages the technical merits of interconnection gradually revealed themselves as power systems grew in size and weight. The greater distances to be covered and the greater powers to be transmitted between the interconnected generating stations made for steadily increasing transmission pressures (Fig. 2) and thus led directly to the crystallisation of the electrical industry around a few large-scale manufacturing organisations possessing facilities and resources for developing high-voltage generating plant, transformers and switchgear resources, which, for better or for worse, are denied to the smaller manufacturing unit. The technical benefits accruing from this mutual process of integration in electricity supply and concentration in electrical manufacture have been enormous and of far-reaching importance. Large-scale users of electric power, such as municipalities, railways and even industrial undertakings (*e.g.*, Imperial Chemical Industries, Ltd., at Billingham) have been in the position to utilise and profit by electrical equipment which would otherwise never have been developed. The introduction of the so-called British grid system, which has made the electricity supply industry in this country a national asset whose worth has been amply proved already during the present war, is the direct outcome of the technical, no less than the economic, benefits of interconnection. The same is true of frequency standardisation, a thoroughgoing policy whose carrying out in Great Britain alone is costing the electricity supply industry some £20 millions. The unification of supply frequencies, however, is only the policy of interconnection driven to its logical conclusion. Such large expenditure on frequency standardisation is in the long run justified, not only by the consequent reduction in capital outlay on turbo-alternators, transformers, motors and converting plant, but also by the simplification and economy in manufacture arising from the use of fewer types of plant and apparatus. To this must be added the fact that the adoption of a common frequency removes engineering difficulties in the way of interchanging energy between different supply undertakings and the ultimate linking up of power systems both nationally and internationally.

The basic principles of power system interconnection were enunciated for the first time in 1904 by Charles H. Merz and W. McLellan, two pioneers who created in the North-Eastern Electric Supply Company, in the years before the last Great War, one of the world's first power systems in which these principles were successfully embodied. At that time relatively high transmission voltages were already in vogue in the United States. In the early days of power transmission by three-phase A.C., during the last

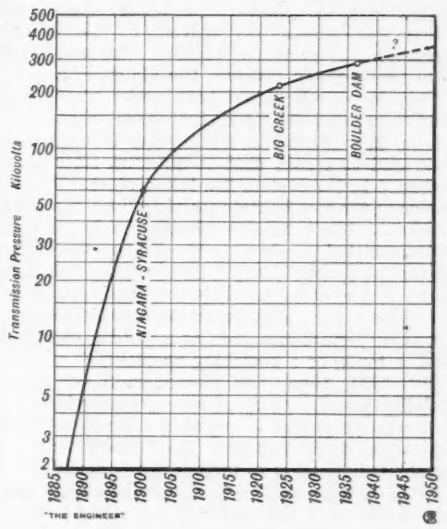


FIG. 2—TRANSMISSION PRESSURES

decade of the nineteenth century,* American transmission lines were operating at 22, 33 and 44 kV. The most important, albeit not the first, long transmission line operating at 66 kV was that between Niagara and Syracuse, which was built in 1900. The transmission distance was 165 miles—a considerable distance physically, although by 50-cycle standards only half that amount electrically, for the transmission frequency was 25 cycles. Further development in the direction of increased transmission pressures was impeded for nearly a decade through lack of a satisfactory pin type insulator for voltages much above 66 kV. The advent of the suspension type of insulator, however, had a stimulating effect on power transmission engineering, and by 1908 the 100-kV mark had been reached and passed. During the years of the first Great War power systems on the American Continent continued to develop and expand, while the voltage of transmission rose from 110 to 132 kV, reaching 154 kV with the Big Creek hydro-electric development in California. This last transmission system employed a double-circuit three-phase line to transmit some 100,000 kW over a distance of no less than 240 miles from Big Creek to Los Angeles. The demand for power grew so rapidly that by 1923 it became necessary to double the carrying capacity of the line, a feat which was successfully accomplished by raising the transmission pressure to 220 kV.

This interesting pioneer achievement, together with the parallel development of the 220-kV, 240-mile transmission system between Pit River and San Francisco, which was completed at about the same time, marked the close of a vital yet preliminary stage in the evolution of power trans-

* The first high-voltage D.C. transmission system was the 2000-volt line connecting Munich and Miesbach, built in 1882 by Deprez and Miller. Thury, the originator of the constant-current system of transmission, erected, during the 'eighties, a number of these D.C. installations, of which the most important was the system built in 1887 to supply the industrial region of Genoa.

mission by means of A.C. at normal frequency.† That stage was characterised by the essentially nineteenth-century concept of progress as a virtually unlimited process of improvement along lines already well established, a concept to which Lord Baldwin once gave unconscious definition as "the inevitability of gradualness." The imminence of a new phase of development was heralded in a somewhat dramatic manner in 1925, when, for the first time, a case of instability occurred on a long-distance high-voltage transmission system operating under normal steady-state conditions. While the possibility of "pull-out" (*i.e.*, loss of synchronism occasioned by a system load in excess of the steady-state stability limit) had been recognised before this experience, its actual occurrence on a large power system stimulated careful investigation of the circumstances under which instability arises in synchronous power transmission. The essentially synchronous character of A.C. transmission along lines established by a quarter of a century's virtually uninterrupted development had been more or less lost sight of in the design of commercial transmission systems. The incident referred to above served to focus attention once more on the fundamental problem of parallel operation of synchronous machines. Initially this problem presented itself in the form known as "hunting," a phenomenon first observed in 1890, when generators were no longer belt driven, but directly coupled to reciprocating engines and when the slotted type of armature came into vogue, and which was successfully solved by Le Blanc's *amortisseur* or damping winding. In its modern form the problem involves the ability of a power system to operate intact both under steady load conditions and during disturbances—that is, to remain in synchronous equilibrium in the steady state and to regain that equilibrium after a disturbance to the system has taken place. What is known as the steady-state stability limit of a transmission system is thus simply the maximum value of transmitted power when the load on the system is increased very slowly. The transient stability limit, on the other hand, is the maximum power the system can carry when it is subjected to a transient disturbance such as a sudden change in load, a fault, or a switching operation.

By 1925, then, the phenomenon of system stability peculiar to synchronous transmission by A.C. was recognised as imposing a purely technical limitation, as distinct from the hitherto accepted economic limitation to further development. This new limitation meant, in fact, that lines longer than about 250 miles could not carry sufficient power to justify the cost of the transmission system, unless the voltage of transmission were raised significantly. But, much more than this, it meant that the development of power transmission was entering a new phase in which novel problems had to be faced, fresh theories had to be evolved, and as yet untried techniques had to be proved first in the laboratory and later in the field. It is to the unending credit of American transmission engineers that they undertook these new tasks with characteristic courage and initiative, and it is to their pioneer work that we are indebted for our present knowledge of the essential factors which contribute to system instability as well as for most of the methods available to-day for improving the stable operation of high-voltage power systems. Synchronous machine theory, the methods of calculating steady-state and transient stability, and the use of symmetrical components in determining the magnitude and distribution of unbalanced fault currents and voltages; super-excitation systems, lightning protection, high-speed oil-poor circuit breakers, and carrier current relaying; the A.C. calculating board and the integraph; all these pioneering achievements are a direct outcome of the intensive study of the fundamental problem of power system stability during the past fifteen years. That study, moreover, included a form of large-scale experimentation which must be unique in the history of electrical development. On several occasions American electricity supply undertakings deliberately subjected their power systems to major electrical disturbances in order to verify experimentally certain vital design data based on new theoretical material. Notably was this the case in 1928, on the 220-kV system of the Southern California Edison Company, and again in 1930, on the 132-kV system of the West Penn. Electric Company.

As the result of the experience accumulated during the preceding decade, the Los Angeles Bureau of Power and Light in 1935 initiated a transmission project that involved the carrying of 240,000 kW from Boulder dam to Los Angeles, a distance of very nearly 270 miles, by means of a double-circuit line of unorthodox design and operating at a pressure of from 275 kV to 287·5 kV between the three phases. This ambitious transmission system, which embodied many novel engineering features, went into commercial service early in 1937 and has been an unmitigated success. At the same time, it represents the limit of achievement set by characteristics inherent in the present method of power transmission—at any rate until such time as it should prove economic to utilise still higher transmission pressures. What is technically possible in this direction may be gauged from the results of a series of tests carried out by the American General Electric Company as far back as 1921. These tests demonstrated that 60-cycle A.C. could be transformed to 1100 kV and transmitted at this pressure, using tubular conductors 4in. in diameter in order to avoid the formation of corona. Having regard to the fact that the flashover distance between points at 1100 kV is about 11ft., it is clear that the cost of the necessary insulators would be abnormally high, as would be the cost of the tubular conductors and of the towers required to carry them. All the same, these tests go far to show that power transmission along lines representing a mere extension of present-day practice, as exemplified by the Boulder dam to Los Angeles transmission system, is feasible at much higher pressures than have yet been used.

*(To be continued)*

† 60 cycles in the U.S.A. and 50 cycles in Europe.

# The Action of the Haigh Fatigue Testing Machine

THE Haigh fatigue testing machine is designed to apply any steady tensile or compressive load up to a maximum of about a ton, and to superimpose on it a cyclically reversing load covering, from maximum tension to maximum compression, a range of anything up to about 1½ tons. If, to take an example, the initial steady load is equivalent to a stress in the specimen of, say, 10 tons per square inch tension, and if the cyclic stress range is from 5 tons tension to 5 tons compression, then under test the specimen will be subjected to a cyclic stress varying from a minimum of 5 tons in tension to a maximum of 15 tons in tension. The initial steady load may be zero, in which case the stress on the specimen ranges between equal values of tension and compression.

A diagram of the machine is given in Fig. 1. The specimen A is held between two crossheads B C, of which the upper is fixed to the main frame of the machine, while the lower is attached by a rod D to a spring beam E, which is bolted at the midpoint of its lower leaf to the base of the main frame. An armature F, fixed to the rod D, lies midway between two electromagnets G G, mounted on the main frame. Within the crosshead B means are provided for adjusting the vertical position of the specimen in order to ensure equality of the air gaps between the armature and the magnets.

The beam E consists of an upper and a lower pair of spring battens, held together by a pair of sliding clamps at each end. By the adjustment of the bolt anchoring it to the base of the machine the beam can be caused to exert on the armature rod and, through it, on the specimen, an upward, downward, or zero force. In addition to supplying in this manner the selected initial steady load, the spring beam fulfils a second important function. With no specimen in the machine, the armature, its rod, and the spring beam constitute an elastically supported mass possessing a natural period of oscillation, the value of which can be controlled by adjusting the stiffness of the spring by means of the sliding clamps at the ends of the beam. Before a test is made the frequency of this oscillating mass is made equal to the number of stress cycles per minute to be applied during the test to the specimen by the magnets. When this adjustment is properly made, the inertia effect of the armature and its attachments is neutralised, and the force applied to the specimen is, or is assumed to be, the net force contributed by the magnetic flux.

The electromagnets are supplied with two-phase current, one phase being taken to the upper and the other to the lower magnet. The current is obtained from a motor-driven alternator, specially wound to give a sinusoidal E.M.F. wave form. The frequency of the stress cycle is twice the frequency of the electrical input, which is normally 1000 to 1200 cycles per minute. To vary the range of the cyclic loading, the potential difference across the electromagnet windings is adjusted by means of the alternator field resistance. A revolution counter on the alternator indicates the number of stress cycles endured by the specimen up to the moment of fracture. The machine is further equipped with a stress meter, which indicates, or is supposed to indicate, the value of the maximum stress applied to the specimen during the test. The stress meter is in the nature of a special milliammeter, and is connected to search coils arranged around the armature pole pieces. In series with the stress meter is a large inductance of low resistance. The stress meter is graduated in arbitrary units which represent to some scale the ratio of the potential difference to the frequency of the E.M.F. induced in the search coils. The square of this ratio is proportional to the maximum flux between the magnets and the armature, and is therefore, according to the usually accepted theory of the machine, a measure of the range of cyclic stress applied to the specimen. The stress meter is calibrated by comparing its readings with those indicated by an extensometer clamped to a special test piece inserted in the machine.

At the L.M.S. Engineering Research Laboratory, Derby, the calibrations of a Haigh fatigue testing machine carried out at different dates were found to disagree with one another by amounts varying from 3 to 5 per cent. Three calibration curves, made at widely separated dates, are reproduced in Fig. 2. All three calibrations were made at 2400 stress cycles per minute, as judged by a tachometer on the motor alternator set. Investigations were undertaken by Mr. E. Warlow-Davies, B.A., Ph.D., to discover the cause of the variation, for it was felt that until it was discovered, results of tests made in the machine would be open to doubt.*

Following the elimination of various possible causes it was discovered that the tachometer had an error which was slowly increasing. Some experiments were thereupon carried out to determine the effect of speed on the calibration results. It was found that a given stress meter reading—120—corresponded to a range of cyclic force of 1·01 tons, at an alternator speed of 1165 r.p.m., to a range of 1·03 tons at 1200 r.p.m., and to a range of 1·09 tons at 1245 r.p.m.; that is to say, at 2330, 2400, and 2490 stress cycles per minute. These results showed that the slow change in the tachometer accounted for most of the observed calibration discrepancies.

While the immediate error was thus traced to its source, the manner in which it was accounted for could not be squared with the generally accepted simple theory of the machine, according to which the calibration should be sensibly independent of the speed. This fact suggested that the action of the machine was not properly described by the theory, and it was felt necessary to resolve this doubt if confidence was to be placed in the test results.

One of the assumptions made in the accepted theory of the machine is that the potential difference applied to the electromagnets is of an exact sinusoidal wave form, and that as a consequence the force in the specimen is also a sinusoidal function of time. By means of a cathode ray oscillograph the electrical wave form was examined and was found to be sensibly sinusoidal, except for the usual high-frequency ripple arising from the armature teeth. The next point to investigate was therefore to determine whether small deviations in the electrical wave form could appreciably affect the force in the specimen. The wave form of the stress in the test piece was examined by means of a Lamb roller extensometer throwing a spot of light on to a screen. This spot under the cyclic stress was projected as a line, the height of which was proportional to the maximum extension

* "An Analysis of the Action of the Haigh Alternating Stress Testing Machine, with Special Reference to the Stress Wave-Form." L.M.S. Internal Report, December, 1939.

of the test piece. By means of a mirror rotated uniformly by a connection to the alternator shaft, this line of light was resolved into a wave with abscissæ proportional to time and ordinates proportional to the instantaneous stress in the specimen.

Examples of the stress wave forms thus obtained are reproduced in Fig. 3, all obtained at a stress meter reading of 120. It will be seen that at a stress cycle frequency of 2330 the shape of the stress curve was a fair approach to being sinusoidal. It became still better at lower frequencies, but at higher frequencies it became worse, the greatest distortion occurring at a frequency of 2490 cycles per minute. Investigation showed that the distortion was independent of the range of stress in the specimen and depended only on the frequency. Additional experiments made it clear that the distortion was not caused by any defect in the indicating equipment.

In this way it was made manifest that while the wave form of the electrical input was satisfactorily sinusoidal, except for the tooth ripple, the wave form of the stress in the specimen might be far

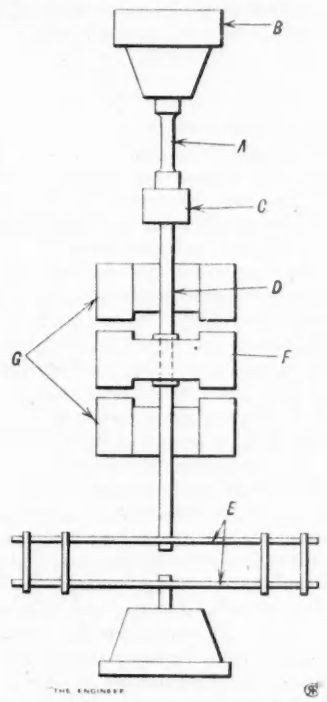


FIG. 1—DIAGRAM OF HAIGH MACHINE

from being sinusoidal. A mathematical investigation was therefore made to determine the extent, if any, to which the stress wave form would be affected by small deviations of the electrical input wave form from the sinusoidal state.

The ordinary simple theory of the Haigh machine assumes, in accordance with Maxwell's Law, that the mechanical force exerted on the armature by the magnets is proportional to the square of the instantaneous value of the flux, and that the flux, in turn, is proportional to the time integral of the instantaneous value of the potential difference applied to the magnet windings. If therefore the potential differences applied to the two magnets are sine functions differing in phase by $\pi/2$, the resultant force on the armature due to the flux will be of sinusoidal form, and will have a frequency equal to twice that of the electrical input.

To allow for small departures from true sinusoidal form in the electrical input, Dr. Warlow-Davies adds a number of odd Fourier series terms to the simple sine formulæ used in the usual theory of the machine to express the potential difference applied to the magnet windings. Using these extended expressions, he obtains an extended expression for the resultant force exerted on the armature by the flux. The first term of this extended expression is identical with the formula for the resultant force yielded by the simple theory. It is succeeded by a number of terms representing small harmonics of both odd and even order.

The system comprising the armature, the armature rod, the spring beam, and the specimen constitutes a mass elastically supported by the stiffness of the spring beam and the stiffness of the specimen. It is forced into oscillation by the force due to the magnetic flux. Using the extended expression for this force, Dr. Warlow-Davies gets the differential equation for a forced undamped oscillation. Solving this equation, he obtains the value of the extension of the specimen at any instant, and multiplying this extension by the stiffness of the specimen, he arrives at the instantaneous value of the stress in the specimen.

In the analysis thus briefly indicated, three frequencies are involved, namely, the frequency $n$ of the electrical input, the frequency $n_1$ of the armature and its attachments *without* a test piece in the machine, and the frequency $n_2$ of the armature and its attachments *with* a test piece in the machine. The setting up of the machine, as already stated, involves the adjustment of the spring beam in such a way that $n_1$ is made equal to $n$. The final formula for the instantaneous stress in the specimen therefore involves only the frequencies $n$ and $n_2$. This final form may be written as

$$T = A\cos\theta + \left\{\frac{C_1\cos 2\theta}{1-(2r)^2} + \frac{C_2\cos 3\theta}{1-(3r)^2} + \ldots + \frac{D_1\sin 2\theta}{1-(2r)^2} + \frac{D_2\sin 3\theta}{1-(3r)^2} + \ldots\right\}$$

where $\theta = 2\pi nt$ and $r = n/n_2$. Since the coefficients C and D are all small, the harmonic terms may be neglected unless the ratio $r$ has certain critical values. Thus, if $r = \frac{1}{2}$, the $C_1$ and $D_1$ terms have as coefficients $C_1/0$ and $D_1/0$, or infinity. Similarly, if $r = \frac{1}{3}$, $\frac{1}{4}$, &c., others of the harmonic terms will have infinite coefficients. Hence, at these critical values of the ratio of $n$ to $n_2$ harmonics of the second, third, or higher order should be superimposed on the stress cycle indicated by the simple theory. From the detailed analysis it can be deduced that the harmonics of higher order should have a smaller magnitude than those of lower order. The analysis neglects the effect of damping, of which a small amount must be present. It can,

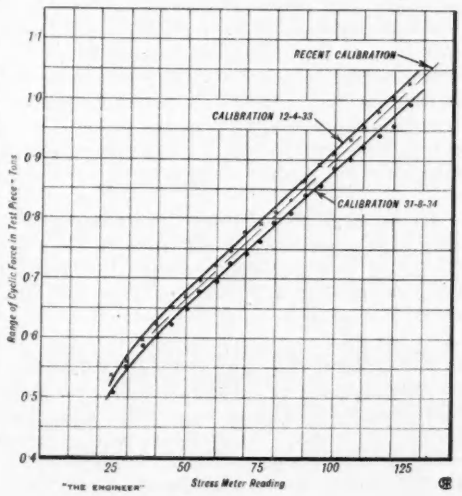


FIG. 2—CALIBRATION CURVES

however, be shown that the effect of a small amount of damping will be to limit the magnitude of the harmonic effect to a finite, but still relatively large value without appreciably affecting the critical values of the ratio $n$ to $n_2$.

The extended theory thus indicates that at certain critical frequencies of the stress application, the inevitable small departures of the electrical input from sinusoidal form may result in a mechanical resonance in the specimen and in the form of the stress cycle being far from sinusoidal. This theoretical deduction was fully confirmed experimentally. By trial it was found that the natural frequency of vibration of the armature system was $n_2 = 10{,}000 \pm 2$ per cent. cycles per minute. According to the extended theory the effect of a fourth order harmonic ought therefore to have been noticed at or about a stress cycle frequency of 2500 cycles per minute, a diminishing effect occurring as the frequency was reduced, until at 2000 cycles per minute the fifth order harmonic should make its presence felt.

These predictions are seen to be in agreement with the results indicated in Fig. 3. They were more completely confirmed by a series of tests carried out at a number of stress cycle frequencies, ranging from 2800 down to 1450 cycles per minute. At 2800 cycles the experimentally determined stress wave form showed only a slight departure from the sinusoidal state. At 2550 cycles the distortion became more noticeable. At 2510 cycles there was considerable distortion of the fourth harmonic type. At 2400 cycles there was less distortion; at 2340 very little distortion; and at 2180 the stress wave form was substantially sinusoidal. At 1980 cycles there was strong distortion of the fifth order harmonic type. At 1760 cycles the stress wave form was sensibly sinusoidal; while between 1650 and 1450 cycles there was appreciable distortion of an indefinite type, indicating the presence of the sixth order harmonic.

Dr. Warlow-Davies is to be congratulated, not only on the outcome of his investigations, but on the manner in which he pursued them. The origin of them was a 3 to 5 per cent. discrepancy in the calibration of the Haigh machine at Derby. This discrepancy was not of much importance on the results of tests in the machine, and was soon traced to the error in the tachometer. Having so traced

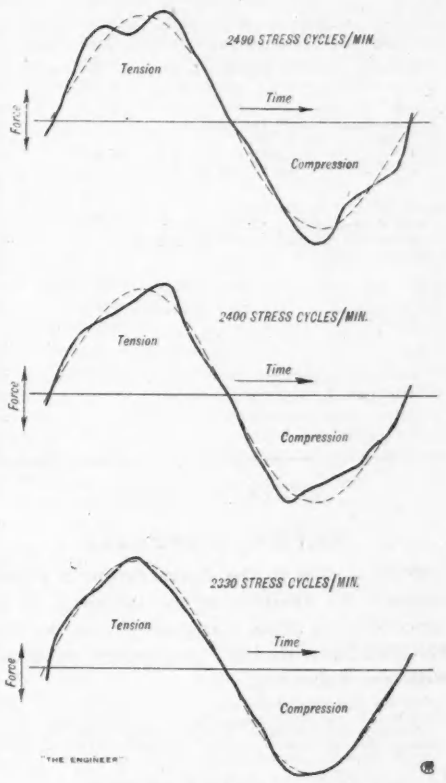


FIG. 3—STRESS WAVE FORMS

it, Dr. Warlow-Davies might well have rested content, but he was dissatisfied with the explanation, because it ought not to have been true, according to the simple generally accepted theory of the machine. Suspecting that the simple theory was wrong, he has now shown that at certain critical frequencies it may break down badly, and that if the results given by the machine are to be accepted as trustworthy, these frequencies must be avoided. The errors introduced if the tests are run at these critical frequencies may be considerably greater than those which would result from the discrepancies in the calibration which led originally to the investigation.

It may perhaps be added that Dr. Haigh himself seems to have been aware of the fact that his machine was open to a mechanical resonance effect which could disturb the soundness of the experimental data obtained with it. This fact seems to us only to enhance the practical value of Dr. Warlow-Davies' investigation, and the clear and decisive manner in which he has expounded and confirmed the phenomenon.

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FURTHER PETROL RESTRICTIONS.—The Secretary for Petroleum announces a new Order (S.R. and O., 1941, No. 669), the Motor Fuel Rationing Order, 1941, which consolidates and supersedes the Orders (S.R. and O., 1940, No. 826, and S.R. and O., 1940, No. 1489) made in June and August last. The main alterations which have been incorporated in the new Order are designed to strengthen the provisions for securing the economical use of petrol and for dealing with infringements of the Order. Any person in possession of coupons must carry and produce them on request to an officer duly authorised by the Board of Trade or by a Chief Officer of Police. Coupons may be impounded if there is reasonable ground for believing that they are evidence that an offence has been committed. The Order also reinforces the prohibition against the acquisition or supply of petrol for a vehicle against coupons which do not relate to that vehicle. Coupons issued for commercial purposes must not be used to obtain petrol for private cars. It is a legal obligation to return to the office of issue all unused coupons (*a*) when they cease to be valid, (*b*) when the purposes for which they are issued cease to apply, or (*c*) when the vehicle in respect of which they are issued ceases to be licensed.

# The Engineer

*MAY 30, 1941*

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## THE LUBRICANTS PROBLEM OF THE AXIS

THE Nazis have succeeded in overcoming the shortage of high-grade aviation fuel by the use of an ingenious, if somewhat intricate, fuel pump on their aeroplanes. The means of injection employed permits the use of comparatively low octane petrol, available from synthetic oil plants and from their few sources of mineral oil supply. The use of low-grade fuel, however, results in German machines flying at lower speeds than would be possible if the motors were run on high-grade aviation spirit, such as is used by the R.A.F. Considerably greater quantities of low-grade fuel can be produced from the original synthetic or mineral oil available for refining processes than would be the case if high octane rating spirit were required. The question of lubricants, however, is one which is causing an acute problem. It is not possible to solve this problem without the Axis gaining control of new supplies of suitable mineral oil, together with the refineries in which this mineral oil can be treated for the production of lubricants.

Before dealing with Irak, Iran, or other oil-producing countries of the Near East now being drawn within the war zone, let us consider the present sources of supply of lubricants open to the enemy. The various hydrogenation plants in Germany treat coals of various types for the production of petrol, paraffin, diesel oil, &c., but it is not possible to obtain first-class lubricating oil by any known synthetic processes. In this country various methods have been tried in efforts to produce a suitable lubricating oil from synthetic oil plants, and lubricating oil with fair viscosity indices (106 to 122) has been obtained by the use of a metallic aluminium catalyst in the reaction between aromatic hydro-carbons and chlorinated paraffins. The pour points of such synthetically produced lubricating oils, however, are high, the cost is almost prohibitive, and only small quantities of satisfactory lubricating oil have been obtained. There is no reason to believe that the German chemists, brilliant though they may be in some respects, are ahead of our own men in this branch of the oil industry. Mineral oil production available to the Axis is estimated to be about 7½ million tons per year, of which Rumania contributes nearly 6 million tons. From the 1½ million tons approximately of crude oil taken from indigenous German and Italian oilfields, from oilfields in Occupied France, Occupied Poland, Hungary, and former Czechoslovakia, the volume of lubricating oil produced per year is insignificant. Rumanian crude oils are not suitable for the production of good lubricating oils. Although many efforts were made to evolve processes which would result in a good-quality lubricant being put on the market, all car owners in Rumania who did not consider low first costs of native lubricating oils before ultimate costs of engine repairs, invariably preferred to use imported American oil, of which large quantities were sold annually. From these facts, it may be well appreciated that there must be a serious shortage indeed of lubricating oil in the Axis countries. War industries, domestic transport of all types, and works producing materials for domestic consumption must all be supplied with quantities of lubricating oil, so vital to modern armies and air forces operating on active fronts and at many training centres. It has been suggested in several responsible quarters that the Nazi drive in Irak is designed to relieve the impending serious shortage of oil products, especially of lubricating oil.

Articles appearing in this journal recently have stressed the fact that glib references to oil of the Near East do not take into account the fact that the great production of crude oil from this area, should it come under control of the Axis, would be of no use whatsoever unless means were available to transport the crude by pipe line, or tank cars on railways, to refineries. There is little or no possibility that our rapidly growing air strength would permit the enemy to get Near East crude to refineries, even if pipe lines and railways, as well as the refineries themselves, fell intact into the hands of the Axis. Irak crude has been suggested as being suitable for refining into much-needed lubricating oil, now that the Nazis have a foothold in that country. Fortunately for us, even should the Nazis be able to transport the crude to refineries, it is not a grade of crude oil which produces a satisfactory lubricating oil. The crude from the Kirkuk field contains sulphur up to 7 per cent., and before it is pumped through the long pipe lines terminating on the Eastern Mediterranean coastline it has to be treated in a special stabilisation plant in operation at Kirkuk. This plant was the result of several years of incessant research work, carried out to evolve the necessary process of removing as great a percentage as possible of the high sulphur content from the crude. Pennsylvania crude produces the best grade of lubricating oil, and this crude has a sulphur content of less than 0·3 per cent. Even after treatment in the stabilisation plant at Kirkuk, Irak crude has to be treated by special and comparatively costly refinery processes to remove the sulphur from the petrol, paraffin, diesel oil, and distillates, which form the bulk of the oil products resulting from refining of this crude. Lubricating oil has not been produced from Irak crude, except in small and very expensive quantities. Lubricating oil of the best grades can only be produced from paraffin-base crudes. Irak crude is of a mixed paraffin-asphaltic type, with a considerable and highly corrosive sulphur content.

All internal combustion engine lubricating oil should be of comparatively low viscosity, and with low boiling points. The destructive action of the heat of an I.C. engine soon breaks down the best grades of oil in the crank case. Oil with high rates of atomisation and volatilisation must be employed as lubricants to enable the oil to pass out of the cylinders before decomposition sets in. As regards viscosity, lubricating oil must have sufficient "body" to afford the protective lubricant film at points of motion and wear in I.C. engines, under conditions of considerable heat. As all crude oils contain sulphur which cannot be removed entirely, even in special refinery processes evolved for the purpose, there are many anti-corrosion dopes put into modern lubricating oils. These dopes are usually chromium oleate, tin oleate, lead tetraethyl, triphenyl bismuthine, &c. Special refinery methods, ranging from the Frasch to the Edeleanu patents, are used to eradicate as much sulphur as possible from the resulting oil products. Irak crude may therefore be ruled out as a potential source of lubricating oil. Crude produced in Iran and in many Russian fields is of the paraffin-base type, but once again, having obtained crude oil from these areas, it must be refined—and refineries are very vulnerable to air attack, should they have been left intact by retreating defending armies.

### Dispersal

THE ideal engineering factory for quantity production is arranged in a continuous line. The raw materials enter at one end and are continuously converted, sausage like, into finished product, which emerge at the other. Furthermore, both ends have easy access to means of transportation—road, rail, or river, the sea, or canal. The fundamental principle involved is that nothing shall ever return upon its traces; every item shall move constantly forward, being converted into new forms and amalgamating itself with new parts until the desired product issues a completed thing at the end of the chain of processes. It is very rarely that such perfection of simplicity is attainable. Usually, the major motion takes place like a river, but it has to be fed by numerous tributaries, in which themselves the same fundamental principle—raw materials at one end, finished product at the other—is observed. The materialisation of this conception of the ideal factory is the multiplication of shops, all adjacent to each other and none of them far from the final assembly shops. Hence, factories have grown up into congeries of buildings sometimes occupying hundreds of acres of ground and all linked together so intimately that the interruption of one will interfere with the operations of all the others—both those that precede and those that follow it. Indeed, in the perfect factory output would be so accurately adjusted that it would be never too fast and never too slow, the whole factory from A to Z operating like a train of smooth-running mechanism.

In a world at peace this was the ideal, and in every industrial nation great examples were to be found. But with the coming of war and especially aerial attack, the merits of the arrangement are its undoing. The sites of vast factories are generally well known, owing to the areas over which they extend they are easy targets, and it is impossible to camouflage them. They have therefore to be especially defended by gun and balloon barrages, and even then, as our Bomber Command has proved over and over again in Germany, they do not escape more or less severe punishment. From the well-known fact that the same targets are repeatedly attacked, as at Kiel, it is clear that even an apparently very successful onslaught rarely causes permanent interruption. Improvised restoration of the damage is carried out, and work is resumed. But unless the damage is relatively small, the conditions can never be quite the same. A spanner has been dropped into the works, and efficiency has been reduced. Moreover, the target still remains, inviting renewed attacks. In some cases—shipyards, to give an example—little or nothing can be done. The risks must be run. But in others the obvious thing to do is to "disperse" sections of the factory. This has, in the first place, the result of reducing the main target, and, in the second, the dispersed parts may be hidden away, so that it is difficult for the enemy to find them. That, of course, reduces output efficiency, for a new set of transport problems has to be solved,

and it introduces a grave difficulty with personnel. Each of the dispersed units becomes virtually a separate works, and it must have its own works manager and office organisation, with the duplication or triplication of many functions. Centralisation is difficult and costly to maintain. In short, an almost complete departure is made from the ideal lay-out described in our opening sentences. But since there is no alternative, the drop in efficiency has to be accepted and set against the increased security. It is probably more than balanced by the reduction in liability to interruption of work by enemy attacks.

This leads to an interesting reflection on the conditions after the war. Not even the most optimistic will dare to assert that the world will never go to war again, or that if it does that aerial bombardment will by general international agreement not take place. What must be done, then, to make industries safe? And not the manufacturing industries alone, but the warehouses, cold storages, grain silos, oil tanks, &c., at ports, and the power-houses, gasworks, and public utilities generally, including the distribution networks. In this country, protected by its "moate," the influence of war upon the conditions of life called until a year ago for little attention. Our roads were not laid out like Continental roads, with the movement of armies as a primary consideration, we had no frontiers to maintain with fortresses, and none of our towns and cities ever considered the possibility of invasion. All that was changed when bombardment from the air began. Then it became manifest that many of the things that had been done because they were the best solution of technical and economical problems introduced elements of weakness. Will the engineer of the future have to think of these things? Will his activities be continually controlled and circumscribed by the possibility of aerial attack? Will he have to sacrifice the best arrangement in subjection to the will of military opinion—even as the Channel Tunnel was given up? That is a disturbing thought. But it has, from the engineer's point of view, its compensation. It will give him a new world to conquer. He may have to design bomb-proof cities. Cities in which all the pipes and cables will be in concrete tunnels; in which the railway stations will be far underground, and in which the power-houses will either be so strong that they can defy the heaviest bombs, or—as was suggested long ago—be as deeply buried as the turbine rooms at Niagara. A hundred and one other problems may present themselves to the ingenuity of the city engineer. And what about the factories? Will they have to be so built of steel and concrete, or so plated with armour, that they can defy 5-ton bombs, or will dispersal which has had to be adopted as a war measure become standard practice? And what of ports and harbours and the dwellings of the people? Will the future see a new architecture, which, like that of the Middle Ages, makes every building a fortress, or shall men see their cities not only walled against invaders as of old, but roofed over against the bomber and the parachutist? Even the remote contemplation of such a world is so appalling that one may dare to hope even against probability that when this fever is done with, convalescent man will decide that never again will he lay himself open to such a malady, and that for ever and a day the manufacture of bombs and bombers shall be prohibited on the face of the earth.

### The "Hood" and the "Bismarck"

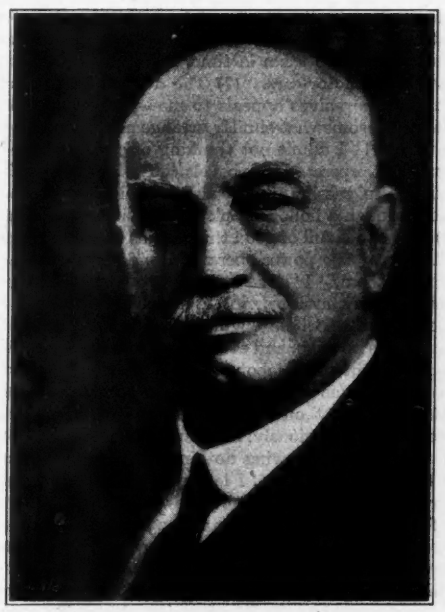
UNTIL more information is available, comments on the cause of the very lamentable loss of the battle-cruiser "Hood" in the North Atlantic on Saturday last, May 24th, can be based only on conjecture. According to a brief Admiralty statement, a lucky shell—presumably from the "Bismarck," with which she was engaged somewhere off Greenland—fired one of the magazines. At the moment of writing we do not know how many survivors there may be, and whether they are in a position or condition to give any clear account of what happened. In these circumstances it must not be hastily assumed that the efforts of the Admiralty to profit by the three calamities of the same general order at Jutland were unavailing. Nor is it publicly known what changes were made in the "Hood," an old ship, when she was modified some ten or eleven years ago. When, if ever, the necessary facts are established, it will be time to examine technically a mishap which, in the unpredictable contingencies of battle, has robbed the British Navy of its largest ship.

Fortunately we are able to set against this disaster the knowledge that the "Hood" had played an important part in operations in which she was, with other ships, engaged. The "Bismarck," one of Germany's newest and greatest battleships, was manifestly about business of serious menace to us. She was met and attacked and was damaged then and subsequently. By extensive operations organised by the Admiralty the "Bismarck" was hemmed in by ships and planes. The contact that had been made was never lost save for a few hours. She was marked down and relentlessly pursued. Twice aerial torpedoes found their mark in her, reducing her speed, and at length she came within range of the guns of our ships. At mid-day on Tuesday the Admiralty announced that she had been sunk by torpedoes. The full story is told in the official report reprinted on another page. So ends the brief history of Germany's newest battleship. She lies at the bottom of the Atlantic, whilst a sister, the "Tirpitz," abides in the yard at Wilhelmshaven, where she is being built, like the two smaller battleships, "Scharnhorst" and "Gneisenau," at Brest, licking the sores that our bombers have raised and not likely to issue for many long months, if ever, unless it be as captives. That is no small thing to set against the loss of even so famous a ship as the "Hood" and the gallant hundreds who manned her. They have been gloriously avenged, and, more important still, a very serious menace to our Atlantic "life-line" has been removed.

## Obituary

### LORD AUSTIN

BY the death of Lord Austin of Longbridge, the founder and chairman of the Austin Motor Company, Ltd., of Longbridge, Birmingham, which took place at his home, Lickey Grange, near Bromsgrove, on Friday, May 23rd, the British



LORD AUSTIN

motor industry has lost a pioneer worker and an outstanding and vigorous leader. Lord Austin was born at Little Missenden, Buckinghamshire, on November 8th, 1866. He received his education at Rotherham Grammar School and Brampton College, and in 1884 he went with an uncle to Australia. He began his engineering apprenticeship at Langland's Foundry, Melbourne, and later became associated with the Wolseley Sheep-shearing Machine Company, Ltd., in due course becoming its manager. It was while in Australia that he was fired with the ambition to improve the means of transport, particularly for those employed in the bush and other isolated spots.

Herbert Austin returned to Birmingham in 1893 to supervise the manufacture of his company's products, first at a very small workshop in Broad Street, and later in larger premises at Alma Street, Aston. As the demand for shearing machines was largely seasonal, the Wolseley Sheep-shearing Machine Company turned its attention to other things, such as the manufacture of bicycle components and small machine parts. The inventive genius of its manager was soon to be seen in the large number of patents taken out in his name.

About that time motor road vehicles were being introduced into this country, and Herbert Austin immediately saw the possibilities of this form of road transport and the realisation of his early ambition. In 1895 he produced his first car—a three-wheeler—which was soon followed by an improved model which was exhibited at the National Show and was described and illustrated in THE ENGINEER of December 25th, 1896. This was a very busy period in Mr. Austin's life; many hours were spent by him experimenting and developing the motor-car, mostly after the ordinary day's work was done. The car he designed and drove in the 1000-mile trial of 1900 won the silver medal and first prize.

The following year he was elected a director of the Wolseley Sheep-shearing Machine Company and later became its chairman. Owing to the firm's success and the potentialities for new business, Vickers Sons and Maxim were approached and were asked to take over the machine tool and motor side of the concern. Such a course was agreed to on the condition that Herbert Austin should be transferred to the newly formed company, and in 1901 he was appointed general manager of the Wolseley Tool and Motor Car Company, Ltd., a position which enabled him to devote all his energies to the new industry just at its birth. With a strong desire to be entirely his own master, Lord Austin founded in 1905 the Austin Motor Company, Ltd., on a very modest capital. His choice of Longbridge as a suitable site on which to develop a factory was no doubt due to his taking the long view, for Longbridge was then outside the city of Birmingham, with plenty of room for expansion, and a small vacant works stood on the main Birmingham-Bristol Road by the side of the Great Western and London and North-Western Railways, with suitable siding accommodation. The factory of 2½ acres employed 270 workers and in the year 1906 produced 120 cars. His enterprise from small beginnings rapidly grew to become one of the leading motor vehicle manufacturing firms in the country, and it gained a world-wide reputation for its products.

During the war of 1914 to 1918 Longbridge became a great munition works and produced millions of shells and other war material. It was in recognition of the important service Mr. Austin rendered to his country that he was created a Knight of the British Empire in 1917.

The period of reorganisation and the years following the war called for still greater effort to face the storm of industrial difficulties and to meet the ever-increasing competition which arose in the motor trade. In 1922 the Austin "Seven" was designed and placed on the market and it soon became the first universally popular small car. Leadership in the motor industry necessitated a close and constant study of Continental and American designs, and Lord Austin was a frequent visitor to France and other countries. He also made extensive tours of American manufacturing plants on a number of occasions.

In his long and successful career Lord Austin held at different times all the highest offices that the British motor industry had to offer. He was also honoured by many engineering institutions and societies. Although much of his time was of necessity spent at the Longbridge works, he found time for much work of national importance, and was particularly interested in the welfare of his own city. Just prior to the beginning of the present war the works at Longbridge had been enlarged to cover 220 acres, and gave employment to more than 16,000 men, about 78,000 motor-cars and commercial vehicles being produced in a single year. Under the present national emergency the production of the company is almost entirely given over to war materials and munitions.

In 1936 Sir Herbert Austin was created a baron and took the title of Lord Austin of Longbridge. In 1938 he was made an honorary life member of the Institution of Mechanical Engineers, and in 1937 the University of Birmingham conferred upon him the honorary degree of Doctor of Law, LL.D.

Other positions which he held were President of

the Institute of British Carriage and Automobile Manufacturers in 1912, President of the Institution of Automobile Engineers in 1931, Chairman of the Greater Birmingham Employment Committee in 1932, and President of the Institution of Production Engineers in 1932 to 1933. In 1934 he was elected a member of the Transport Advisory Council, and the same year he held the office of President of the Society of Motor Manufacturers and Traders. In 1936 he joined the University of Cambridge Appointments Board, and in the following year was appointed Chairman of the Shadow Aero-engine Committee. In 1937 he was elected an honorary member of the Institute of British Foundrymen, and in 1939 he became President of the British Cast Iron Research Association. Last year Lord Austin was made a life member of the Court of Governors of the University of Birmingham, and was also elected President of the Motor Trade Association.

### EDWARD OTTO FORSTER BROWN

MINING engineers, not only in this country, but also in many parts of the world, will learn with deep regret of the death, on Thursday, May 22nd, at Fountain House, Park Lane, of Mr. Edward Otto Forster Brown, the President of the Institution of Mining Engineers. Mr. Brown, who lived at 14, Chester Square, and "Holbrook," Chislehurst, was fifty-nine years of age. He was in good health until recently, but following a chill broke a blood vessel and died after a short illness. He was a well-known mining engineer with a wide experience and a high reputation, not only in this country, but also in South Africa, North America, Mexico and the Far East. After serving his apprenticeship he practised for some years as a consulting engineer in Mexico, and on his return to England was extensively engaged on mining engineering consulting work in London, specialising in coal and iron ore mining. In 1923 he was awarded the Telford Gold Medal of the Institution of Civil Engineers. In 1926, assisting the late Dr. Haldane, who represented the Institution of Mining Engineers, he gave evidence before the Samuel Commission. He was a member of the Royal Commission on Safety in Coal Mines in 1937. Forster Brown was known intimately in all the British coalfields and was an authority on the Kent coalfield, in which he served as Chairman of the District Mining Board. He was for some time a Governor of the Imperial College of Science and Technology and a member of the Board of the Geological Survey of Great Britain. His death at a comparatively early age will be deeply mourned by his many friends and his colleagues in the Institution of Mining Engineers. He was elected President of the Institution in 1939 and served in that office up till the time of his death. He rendered valuable service to the Institution, not only as its President, but in the many consultations with the Mines and other Government Departments.

## Letters to the Editor

*(We do not hold ourselves responsible for the opinions of our correspondents.)*

### THE SOUTHERN RAILWAY "PACIFIC"

SIR,—The description of the Southern Railway "Pacific" in THE ENGINEER of March 14th makes me both happy and homesick. It is comforting to find that, in spite of the malice of the enemy, new types of locomotive still take to the rails, and it is also comforting to see embodied in this particular design so many of the features that my experiences on both sides of the Atlantic have led me to suggest as desirable, or at any rate worth a trial. Some I have referred to again and again—"rubbed it in," in fact. I make no claim to expert or exceptional knowledge where locomotives are concerned; I am merely a keenly interested looker-on, who, though I may not have "seen most of the game" of locomotive operation, has had the opportunity of making a good deal during the 30,000 miles covered in the cabs of many representative engines the last two or three years. What I have noticed I have tried to describe, very much in the hope it would be of interest to others, and might perhaps lead to reciprocal adoption of ideas, because nothing has struck me more during my travels than the abysmal ignorance shown by many railwaymen in one country as to practice in another. The Atlantic seems to be a great gulf fixed between two divisions of the locomotive brotherhood, and not always merely affecting the lower ranks and ratings either. The gulf should be bridged as often as possible.

Returning to the Southern "Pacific," I rub my hands at (1) the 280 lb. steam pressure. A 250 lb. maximum seems to have been sacrosanct in England ever since 1927—"thus far shalt thou go, and no farther." In America 250-300 lb. has been common for some time; (2) thermic siphons, used on thousands of American engines for years past, and well worth trying in England. The siphon increases the heating surface where every square foot tells most, improves circulation where it is least satisfactory, lessens risk of damage to the crown sheet in the event of low water, and makes support to the brick arch much better; (3) steel fire-box. Why should copper be a fetish in England, and nowhere else? It looks rather like a habit! I am not suggesting for a moment that copper is bad, and steel far better, but a real trial carried out over a long period should be good policy and would be very interesting. I have seen it stated that steel boxes won't stand the fire-forcing demanded by the small grates common on British engines. This may or may not be so—I do not know. But do these advocates really imagine fires are not forced out here? They would alter their opinions if they travelled in the cab of an engine hauling a 3000-ton freight train at 60 m.p.h., or an 8000-ton wheat train at 30, with a mechanical stoker going full bore. (4) Ample boiler power, grate area and fire-box volume—fine. Nothing makes me unhappier than watching an over-cylindered, under-boilered engine fight a losing battle in an attempt to achieve the impossible and yearning over a perspiring fireman struggling to do the same thing. I have come near to a nervous breakdown more than once on this account—not only on British engines, I hasten to add. On humanitarian grounds the equipment of such engines should include an oxygen tank. (5) Electric light—I knew it would come, and here it is. See "The Midday Scot" story, THE ENGINEER, September 1st, 1939, and several other plaintive cries. Of course, it is not *necessary*, but neither are many things we look upon as customary nowadays. An oil lamp cuddling up against the water gauge as the sole source of illumination in the cab can be made to *do*, I suppose—it has had to long enough, the Lord knows! In 1825 they made a perforated bucket of coke do for a tail light; did without a cab, or even a hand rail round the footplate. And enginemen made top hats do as a head covering once upon a time, too. But this is 1941, in an electrical age.

(6) Double disc wheels. Well, spokes do seem very much a habit, when you come to think of it; "Boxpok" wheels have had considerable use out here in recent years, somewhat the same sort of thing. Rims will not get out-of-round so easily, and as for æsthetics, "handsome is as handsome does"—we shall get used to them in time, no doubt, just as we have with motor-cars. (7) The dummy cross shaft working the valves appeals to me—partly because I planned a somewhat similar arrangement myself two years ago! I admit not thinking of chain drive—it was shaft operated by bevels. The former is far better. In passing, is forced lubrication for the big ends through a hollow crank axle feasible or foolish? (8) The cab is full of good things, aids to comfort and efficiency. The power-operated fire-door is certainly one of them. I have referred to this time and again in my articles, and am delighted to see it adopted on a British engine. The fireman on a big engine has no snap, and everything possible should be done to lighten his labours. One has only to travel on engines thus equipped, and then on others not so fitted, to see at once the advantage of mechanism over muscle. Curiously, in an article written a couple of months ago, knowing nothing of the near advent of the Southern engine, I let myself go again on this very matter. "Coming events cast their shadows before." The door in the picture on page 181 looks like the "Franklin," so popular out here, but the photo does not go far enough south to show the treadle, which, I presume, is there. Is the door vacuum or steam operated? (9) The hanging either-side regulator handle, similar to the L.N.E.R. type, is admirable, quite the best of any I have noticed in England. The hanging throttle lever, catch-held, is standard in America, but is only found on the driver's side. (10) Mr. Livesay *is* glad to know "stuffed seats" are provided! A proof that man's humanity to man is not merely a figure of speech, and that it will not be allowed to perish from the earth if Mr. Bulleid can prevent it. Granted, Nature thoughtfully puts padding on the average bottom, but not always enough—it is unwise to bank on this shock absorber. Besides, speaking for myself, corns can form on it, which is less likely if additional padding is put on the seat. (11) The "air-smoothing" should do much to keep the windows clear of steam, which can be an infernal nuisance sometimes. Incidentally, it has occurred to me, why not extend the cab roof a couple of feet forward over the windows, so the look-ahead would be through a covered porch, as it were? This would not reduce the field of vision, would keep wet and smuts off the glass, and help to prevent sun-dazzle. A good look-ahead is very important, and has been impossible under some circumstances with several engines on which I have ridden. I have noticed front windows absolutely useless, blacked-out with wet, chimney oil and soot, forcing the men to put their heads into the rain-laden slipstream past the cab, and to keep them there, chancing eye injury from cinders, grit and cold. This should not be, and need not be. Which reminds me; most enginemen in this country wear goggles, but I only remember seeing one doing so in England, out of all the hundreds I have travelled with there. I wonder why this is. They are invaluable. Habit again?

Weight cutting seems to have been cleverly done on this engine—a 48·5 square foot grate, yet only 14 tons on the trailing axle. Altogether a very fascinating locomotive—the sooner I see it the happier I shall be. My kindest regards to "gallant little Cheltenham," the Tunbridge Wells tanks, and their sisters—including Mr. Cobb, who introduced me to them. My heart is with them in these sad days; I wish the rest of my useless person was, too.

EDWARD H. LIVESAY.

Cordova Bay, near Victoria, B.C., Canada,
April 24th.

### SALARY OF ENGINEERS IN GOVERNMENT SERVICE

SIR,—I note in your issue of May 9th an advertisement on behalf of the Air Ministry requiring Clerks of Works, Order No. 637. The qualifications demanded are as follows:—

"Experience in actual appointment as clerk of works or foreman on large construction works essential. Experience in the erection of structural steelwork, road construction, brick construction, reinforced concrete, drainage, laying of water mains and general works appertaining to development of estates also necessary. Must be capable of accurately setting out buildings. Age limits, 30–55. Salary up to £300 a year fixed."

Now a short while ago there was issued a fifth report from the Select Committee on National Expenditure, Session 1940–41, which contained a report from the Sub-Committee on Army Services relating to the erection of militia camps. These camps were estimated to cost £21,000,000, but in effect cost some £60,000,000 to construct.

Section 18 of the Sub-Committee's report, under the sub-heading "Qualities of Supervisors," includes the following:—

"Great difficulties have been encountered in procuring supervisory staff of a sufficiently high standard at the rate of pay offered. In the higher grades the expansion could be met by calling upon retired officers of experience, but in the lower grades recruitment from civil life was the only course open, and thus recruitment has had to take place in the open market in an unfavourable field, and was further aggravated by the offer of wages far below the market rate. Early in October, 1940, the War Office authorised the engagement, as a special temporary measure for defence works and hutted accommodation, of clerk of works at £8 per week, in order to allow the authorities to enter the open market on reasonable terms."

The above paragraph is preceded by the sentence: "The lesson to be learned from this case is widely applicable."

The "case" referred to is dealt with in a previous paragraph, where it is recorded that there had been "a remarkable absence of adequate supervision of work done." Evidently, Sir, the lesson to be learned from grossly underpaying skilled men has not yet been learned. Whilst it is, of course, common knowledge that the heads of some of the largest industrial undertakings in this country have yet to learn the value of skilled professional labour, and continue to pay inadequate salaries to professional engineers, it is somewhat remarkable to see the Ministry concerned advertising such an inadequate salary as the one offered in the advertisement quoted at the commencement of this letter, after the publication of such a report as that referred to.

No firm of contractors would dream of paying a salary of "up to £300 per year" to the general foreman they would employ to carry out such contracts as would be supervised by the clerk of works now being advertised for by the Air Ministry, for the very simple reason that they could not obtain qualified and experienced men.

It seems to me that any man in a supervisory position should know at least as much as the man who

is being supervised, and that he should be paid accordingly.

In all parts of the country bricklayers, carpenters, fitters, &c., are obtaining more than the salary that is now offered, so what sort of result does the Air Ministry think it will get by employing a man "up to £300 a year" to supervise the work of a man who is paid at least £500 a year and probably gets an "out allowance" of a couple of pounds a week as well?

D. A. RUSSELL,
A.M.I. Mech. E.

Market Harborough, Leics, May 21st.

### SUPER-SUMMERTIME

SIR,—The witty Leading Article on "Super-Summertime" in your issue of May 9th makes one wonder whether it is really necessary that most of us should be tied to bench or office stool for all the daylight hours of our short winter days.

It may or may not be practicable to incorporate a mechanism in our clocks to make them register nine o'clock at sunset throughout the year, but there is no reason why they should not be advanced one hour each month in autumn and retarded one hour per month in spring. In this way, taking normal summertime in May, June, and July as a basis, your ideal of sunset at 9 p.m. throughout the year would be very nearly realised.

The following table gives times of sunrise and sunset at the 15th of every month under this scheme :—

| 15th of | Sun rises. | Sun sets. | Advance of clock on G.M.T. (hr.). |
|---|---|---|---|
| January ... ... | 1.07 a.m. | 9.13 p.m. | 5 |
| February ... | 11.18 | 9.10 | 4 |
| March ... ... | 9.16 | 9.03 | 3 |
| April ... ... | 7.03 | 9.0 | 2 |
| May... ... ... | 5.03 | 8.50 | 1 |
| June ... ... | 4.33 | 8.27 | 1 |
| July... ... ... | 4.50 | 8.20 | 1 |
| August ... ... | 6.40 | 9.29 | 2 |
| September ... | 8.32 | 9.17 | 3 |
| October ... ... | 10.26 | 9.0 | 4 |
| November ... | 12.22 p.m. | 9.0 | 5 |
| December ... | 1.08 | 8.42 | 5 |

For three winter months the sun would not rise until nearly lunch time, but would it not be worth putting up with that to get light evenings in winter?

Furthermore, most industrial work can be carried on by artificial light as well as by daylight, but the same cannot be said of outdoor recreations. Improved health gained by outdoor exercise in winter would not be the least of the advantages accruing.

R. DESMOND PARKER, M.Sc.

Belfast, May 22nd.

## Production of Magnesium in America

THE United States Bureau of Mines has announced that it is ready to proceed with initial tests of a special process it is developing for the production of magnesium metal. The tests will take place at a small pilot plant just completed by the Bureau at Pullman, Wash. Extensive laboratory experimentation on a method for the direct production of magnesium from magnesite ore has proved sufficiently encouraging to warrant trying the process on an engineering scale.

Magnesite ore, which the Bureau's process utilises, is found in abundance in a number of areas throughout the United States, and some of the largest deposits, variously estimated as from three to seven million tons, are situated in the State of Washington. The magnesium deposits in the area are being worked for high-grade magnesite as used in refractories. In addition, there are large reserves of low-grade mineral for which there is no immediate industrial use.

The Bureau started work on the possibilities of producing magnesium metal directly from the ore by reduction with carbon. Experiments had been made in Europe, and small plants had been built in which magnesia was reduced with carbon in an electric furnace, and the magnesium and carbon monoxide vapours chilled in an atmosphere of hydrogen to prevent re-oxidation. Since hydrogen is a relatively expensive gas and large volumes are necessary to cool small volumes of magnesium metal vapour, and since hydrogen carries with it the danger of explosions, the Bureau undertook to develop a new method of chilling the vapour. Early experiments in the laboratory at Pullman indicated that a spray of hydrocarbon oil could be substituted for the hydrogen. At the same time, a successful method was developed for the flotation of the lower-grade magnesites, which enabled the Bureau to use the concentrates produced by this method in its process for production of magnesium metal.

Commercial production of magnesium in the United States did not begin until 1915, when the World War interrupted imports from Germany. Production which totalled 87,500 lb. in 1915, and reached 284,118 lb. in 1918, dropped off after the war. About 1925 the demand for the metal gradually began to increase until sales totalled 1,434,893 lb. in 1933. They then rose rapidly to reach a record peak of 12,500,000 lb. in 1940. Largely responsible for this growth was the use of magnesium alloy structural products, the production of which increased from 114,464 lb. in 1930 to 2,365,260 lb. in 1939. During the World War years there were as many as five domestic producers of the metal, but by 1920 only two remained. The American Magnesium Corporation discontinued production in 1927, leaving the Dow Chemical Company the sole producer of magnesium in the United States at the present time. This firm produces magnesium by the electrolysis of fused magnesium chloride recovered from underground brine at Midland, Michigan, and from sea water at Freeport, Texas. Recently another firm has obtained a loan from the Reconstruction Finance Corporation to construct a plant on the West Coast.

Primary magnesium production in the United States during 1940 amounted to 12,500,000 lb., the largest output in the history of the domestic industry, according to the Bureau of Mines, United States Department of the Interior. The 1940 output was 87 per cent. above the previous peak of 6,700,000 lb. attained in 1939. The Dow Chemical Company, at present the sole domestic producer of magnesium, expects to produce 30,000,000 lb. of metal in 1941. In February, 1940, the company doubled the capacity of its plant at Midland, Michigan, which utilises magnesium chloride derived from underground brine, and in January, 1941, production was begun at a newly constructed plant at Freeport, Texas, which employs sea water as the raw material. Domestic sales of new magnesium in 1940 equalled the production, and showed an increase of 17 per cent. over the 10,650,121 lb. sold in 1939. The tremendous demand for magnesium in 1939 and 1940 is attributed chiefly to the national defence programme. Not only did the aircraft industry, principal consumer of the metal, suddenly increase its production, but it also began using magnesium base alloys in more parts than formerly. Certain non-aircraft industries, such as the automobile, portable and high-speed tool and equipment, textile, and other users, also extended the structural use of the metal. The use of non-structural magnesium products also advanced. The munitions industry employed larger quantities of magnesium powder in the manufacture of tracer bullets, star shells, and flares.

In order to keep pace with the requirements for magnesium products, the fabricating industry greatly expanded its plant facilities in 1940. The American Magnesium Corporation announced that it would triple its fabricated magnesium output to cope with the demands of national defence. The Dow Chemical Company and other fabricating companies also extended their foundry, rolling, extruding, and milling facilities.

Since magnesium began to play a vital *rôle* in the construction of aircraft, attention has been focused upon world production. While official data are not available, it is believed that the total world magnesium output did not exceed 45,000 short tons in 1940. The world producers in 1940 in apparent order of importance were Germany, the United Kingdom, the United States, Japan, France, U.S.S.R. Italy, and Switzerland. According to sources believed to be reliable, production in Germany, the largest world producer, was between 18,000 and 21,000 tons in 1940. Germany employed carnallite, potash end-liquor, and some magnesite and dolomite as raw material in the production of its magnesium. The electrolytic magnesium chloride process was employed, but experiments were recently begun on the direct thermal reduction of magnesium oxide. German uses for magnesium, owing to the local lack of certain other metals, include telephone switch parts, optical instruments, microscopes, bus-bars, and aerial bombs. In the manufacture of engraving plates, copper-zinc alloys have been replaced by magnesium alloys. Automobiles, street cars, and tanks are understood to offer some of the most important outlets for the present German supply of magnesium alloy.

## "Defeating the Bomber"

WE feel confident that the public will welcome heartily a little book called "Defeating the Bomber," which Dr. H. E. Wimperis has written for Dent's series of Liberty Handbooks (1s.). It is manifestly addressed to the ordinary reader, and in no small part, we suspect, to that legion of lay inventors who inundate the three defence departments with suggestions for countering the attack of the enemy. With these inventors Dr. Wimperis deals sympathetically. He does not seek to discourage them, but he does endeavour to indicate to them how and where they may go wrong through lack of precise knowledge; and he explains as simply as may be the limitations to such things as "homing" projectiles, pilotless aeroplanes, death rays, and other inventions of that order.

The little volume opens with an introductory chapter in which a general survey of bombing and its problems is presented. Here there may be found some interesting figures that help the reader to get bombing into its proper perspective. We will not rob Dr. Wimperis of a single reader by quoting them, but we may mention a striking passage in this chapter, in which "trigger action" is dealt with: "The bomb pulls the trigger and some great store of energy already existing in or near the target is suddenly released." The store of energy may be a chimney or a building or a moving train or a dump of explosives. The building may fall on others, the train may be derailed down an embankment, the explosives may do vast local damage. It is only when this secondary action takes place that bombing, if it is to do military damage, is "worth the effort taken to produce it."

In his second chapter Dr. Wimperis discusses bomber aircraft and their limitations, and in the next two deals with the means of defence from the ground and from the air. Here he has managed to compress an astonishing number of facts into the space at his disposal, and he presents them with such simplicity and clarity that even the completely non-technical reader cannot fail to understand them. The perusal of these pages should put an end to much loose writing and talking, and it is to be hoped that they will be very widely read.

In his last chapter Dr. Wimperis leaves the bitter facts of the present and probes into the future. "Is Outlawry Possible?" he asks. He reminds us that at the Disarmament Conference of 1932–34 the total abolition of the bombing aeroplane was earnestly debated. "Failure to bring about agreement," he writes, "was due less to lack of idealism than to the technical difficulties in the way." The principal difficulty was then that civil aircraft could be so readily converted into military machines. That is not the case now, and Dr. Wimperis suggests that by using speed as the criterion a definite distinction might be made. "It should not be impossible, therefore," he writes in conclusion, "when the present war is ended to provide by international agreement for the outlawry of bombing aircraft. Certainly the technical difficulties that used to stand in the way no longer do so. The sting of the airplane would in this way be drawn and man could think gratefully of the discovery of flight."

## Sixty Years Ago

HENRY PEASE

IN our issue of June 3rd, 1881, we recorded the death, on May 30th, of Mr. Henry Pease, at the age of seventy-five. He was the son of Edward Pease, the "father of railways," and was born at Darlington. In his early years he was sent to learn the business of a tanner, but soon gave up that calling in preference for railway work. While still quite a youth he took an active part in the management of the Stockton and Darlington Railway, and when that undertaking was merged in the North-Eastern Railway he retained his seat on the board of management. While taking an important part in the extension of the railway system which his father had originated, he found time to devote himself to commercial pursuits, politics, and social reformation. His family was almost, if not quite, without parallel in this country in its gigantic industrial operations. It owned many collieries in Durham, ironstone mines in Cleveland, and lead workings in the northern dales. Henry Pease's brother Joseph was the founder of Middlesbrough, and he himself founded Saltburn, the watering-place at the terminus of the Darlington section of the North-Eastern Railway. In 1857 he was returned to Parliament as Member for South Durham, and sat in the House for eight years, until he voluntarily retired in favour of his nephew, Joseph Whitwell Pease. He was a member of the Society of Friends and of the Peace Society. In 1853, together with two other members of the Society of Friends, he journeyed to Russia for the purpose of endeavouring to prevent the war which then seemed imminent between us and that country. They were received in a kind manner by the Czar, but their efforts were unavailing. Shortly afterwards he took part in another embassy to the Emperor of the French to urge him to use his influence in calling together a congress of European nations to promote the interests of peace. The Emperor received the deputation cordially, but again the object which it had in view was defeated.

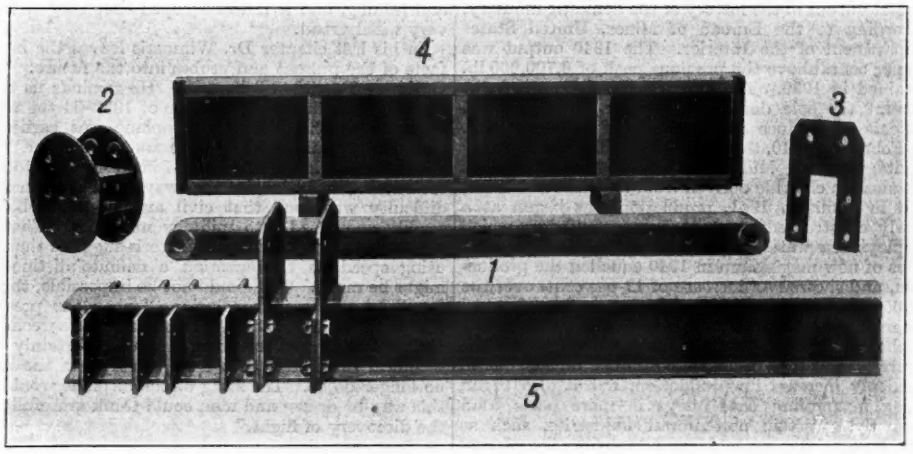
SWEDISH WATER POWER RESOURCES.—Sweden's difficulties in importing sufficient quantities of fuel, both liquid fuel and coal and coke, owing to the war, and the heavily increased prices for these fuels, have given rise to an accelerated development of the country's water power resources. Several big water power plants are under construction in various parts of the country for the State as well as for private owners, and others are planned. According to official figures, plants totalling about 430,000 kW were under construction at the end of 1940, while plants completed had a total capacity of 1,899,000 kW, representing an increase of 120,000 kW during the year. Sweden's total power consumption amounted to about 9 milliard kilowatt-hours in 1940—the same as for 1939. About 94 per cent. of this power was water generated, while the rest, 6 per cent., was produced by steam.

# The "Butterley" Standard Bridge

THE possible destruction of vital links in communication, not only by military damage in war zones, but by natural causes in countries overseas, requires the speedy replacement of bridges, and for this purpose some form of structure is essential which can be stocked, quickly transported to site, and rapidly erected under adverse circumstances. Temporary bridges of this nature obviously lend themselves to some measure of standardisation. In this connection the Butterley Company, Ltd., has designed a series of standardised members for bridges which should not only serve the needs of emergency replacement of damaged bridges, but also permit of the assembly and rapid erection of permanent bridges of a wide variety of designs.

In designing the standardised members, for which a patent has been applied for, the originators have had in mind the most complete simplification possible, combined with great versatility in application. At the same time, the cost of production has been borne in mind, and the application of welded methods of fabrication has resulted in parts which are simple to produce, have minimum weight for strength, and require no riveting either in the production shops or on site during erection. The requirements of overseas and up-country erection have also been studied, of accuracy and are completely interchangeable.

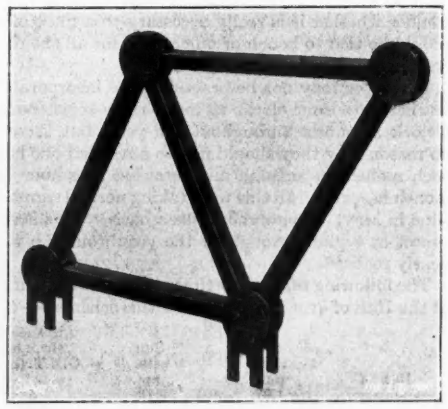
A standard girder member (1) is used to form all chord and diagonal members. It is a box section, 8in. by 6in. in ¼in. steel, 9ft. 4in. long, the section being formed from two L-shaped pieces consisting of plates bent at one corner and welded together longitudinally at two opposite corners. A round bar, 5½in. diameter by 8½in. long, is welded into position at each end and the box section, shaped, hammered and welded to the boss, finishes at the extreme end with a butt weld. The ends are jig-bored with holes to take 2in. diameter connecting pins. Three holes, reinforced with welded-in tubes, are provided for handling and the insertion of bolts for erection derricks.




STANDARD BRIDGE COMPONENTS

At each intersection point a circular connecting bobbin or drum (2) is provided to take all connections. This consists of two circular plates, 1ft. 1lin. diameter, placed 8in. apart, with two plates welded between. Six holes, strengthened by bosses and plates welded inside the bobbin, are provided to take the pins through the ends of the chord and diagonal members, and a central hole is provided for the bar connections. At each intersection on the bottom chord of through bridges (top chord of deck bridges) a cross girder suspension plate (3) is attached to the connecting bobbin. This plate is an inverted U-shaped plate jig-drilled for pin connections and having also bolt holes in the leg portions for the cross girder connections. The cross girders for footbridges are the standard box girder units as used for chords, but with the addition of a mild steel bracket and standard pin for fixing to the suspension plates. For roadway and heavy bridges another standard item is provided, consisting of a cross girder unit (5). This is a rolled steel joist, 20ft. long of 15in. by 6in. by 45 lb. section, and is placed at 10ft. centres at the intersection points. Wing plates are welded to the web for connecting to the suspension plates. Three sets of these wing plates are provided at each end so as to suit one, two or three girder connections, which may be used for heavy bridges, as described later. The ends of the cross girder joists are drilled for gangway attachments. On wide road bridges fenders consisting of the box section girder are provided. These are secured by bent bars passing through the holes in the bosses.

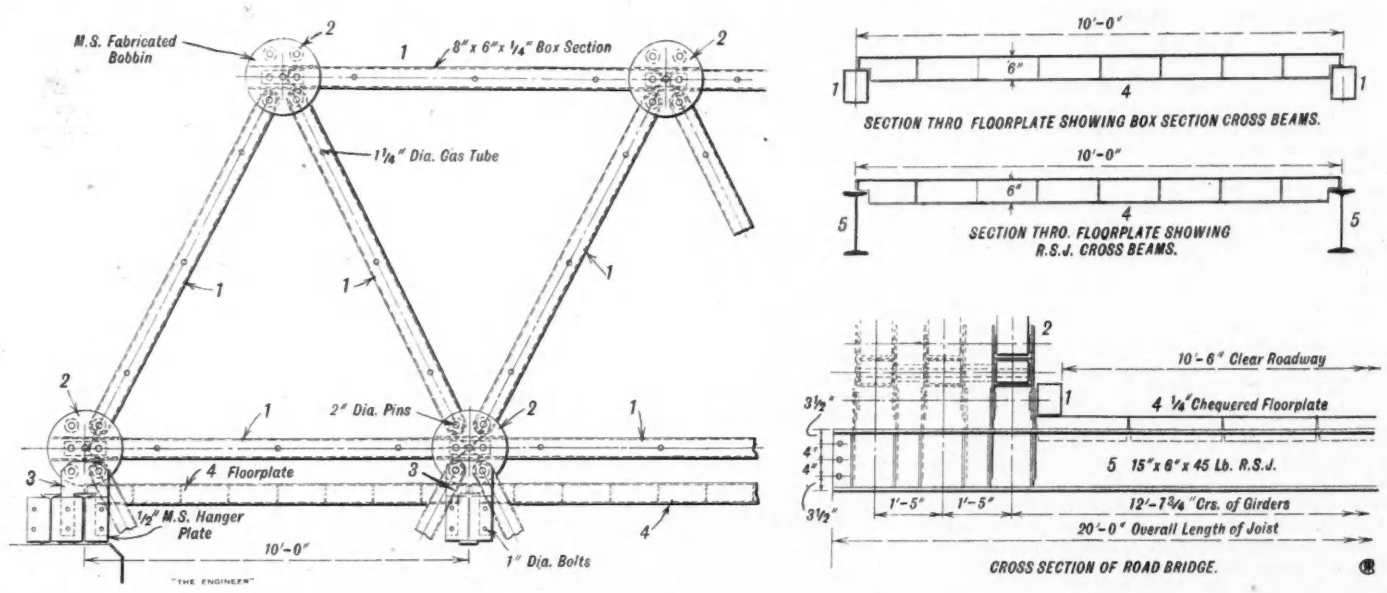
Standardised floor plates (4) are used, having ends and sides flanged downwards and with cross bar stiffeners welded on. The plates are chequered, ¼in. thick, 10ft. long and about 2ft. 6in. wide. The ends are notched for bedding into the cross girders. The floor plates are placed longitudinally with the span and there are no bolted connections. As they fit to the sides of the bridge no deck sway bearings are necessary. A standard type of mild steel turned pin, 2in. diameter with nut and split cotter, is used throughout for all connections. The heads of those pins which pass through the suspension plates and which are longer than the ordinary pin, are made of different shape to facilitate identification, especially if erection is taking place during dark hours.



ASSEMBLY OF COMPONENTS

For light bridges, the structure consists of one row of the box girder chord and diagonal members along each side. For heavier bridges one or, for very heavy loading, two additional box girder side structures can be used, the original and the additional members being connected together by tie bars and distance pieces through the central holes of the drums. It is for the accommodation of these extra side structures that the joist cross girders are provided with three sets of wing plates at each end. It is obvious that, if it be desired to strengthen a bridge to take heavier loads than the original structure could carry, this can easily be done by the construction of an extra side structure on the wings already provided. Heavy bridges and those of large span may have their side structure built up in a double tier, the construction being carried out by means of the standard connecting bobbins at the intersections of the box girders. Overhead bracings may be provided. The abutment bearings of bridges are arranged to take two ordinary cross girders through the suspension plate.

This unit construction, it is claimed, permits the design of a very great variety of bridges of different types. The various standard members are propor-




DETAILS OF STANDARD BRIDGE ASSEMBLIES

in that no part is of excessive weight, all of them being capable of handling by men with light appliances. The design also incorporates features which assist in erection and the attachment of tackle used in erection. The "Butterley" standard bridge comprises five different standard units which suffice for the construction of all types of bridge. The essential feature is the use of standard chord and diagonal members placed in isosceles triangles with intersections at 10ft. centres. For light footbridges only four of the standard members are required. Bridges can be either of the "through" or "deck" types. The five standard members are made on jigs to a high standard

tioned to carry loads from light bridges to heavy, and over single spans up to 150ft., in steps of 10ft. Bridges of over 120ft. span and of the heavy type require a double-tier construction below or above the main tier, with double or triple-side girders. For spans above 150ft. and for multiple-span bridges there would be approach and intermediate spans up to 80ft., the bridge being carried at intermediate points by trestles, themselves consisting of standard units which can be continued through the girder system. Expansion can be arranged in a long bridge.

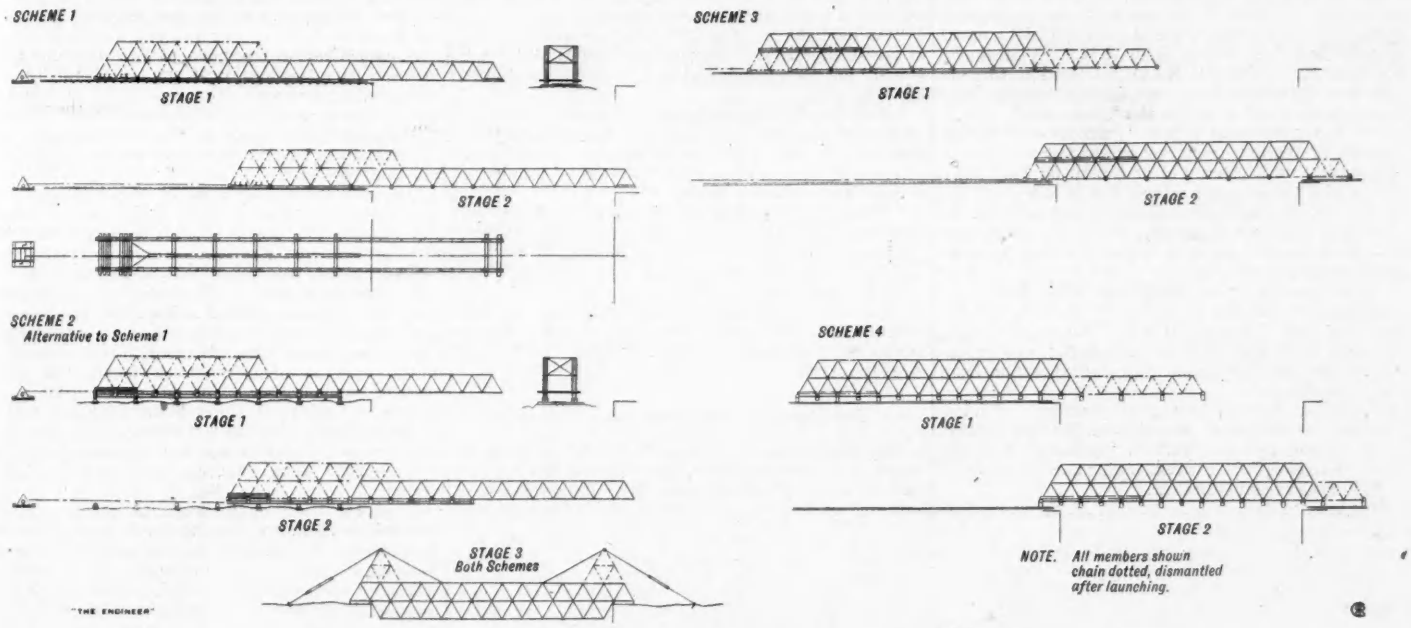
Erection is carried out by erecting several bays on one abutment and ballasting them with available cross girders and floor plates and then by continuing on the cantilever principle. An erection derrick consisting of a mild steel tube, 20ft. long by 2in. diameter, is secured by bolts to one bottom member of the girder chord and one diagonal member. For this purpose tubes are welded through the bridge members at their mid-points for the insertion of the bolts. When one bay has been erected the derrick is dismantled and moved forward for the erection of the next bay. Launching of the girders to the erection point can be arranged by using standard-gauge track and with rollers fixed to the lower drums of the girders through the 2in. diameter pin holes. A description of the launching procedure is given later. "Deck" type spans are constructed as "through" spans. The cross girders are suspended under a top chord instead of the bottom chord as in the "through" type. When erection is completed the girders are lowered on to the abutments by means of a square thread screw and nut, the screw being mounted on a trestle constructed of standard units. Tie rods can be arranged between the bottom chords of the main girders and handrail standards, rope guards being fitted at girder intersection points.

Three different schemes of launching a bridge of 120ft. span are illustrated in one of the accompanying engravings. In the first method one tier of the bridge is erected with additional units to form a counterbalance on approach. The approach is suitably levelled and has flat-bottom rails laid longitudinally and dogged to sleepers. Alternate bottom chord bobbins have small double-flanged wheels fitted in their two lower holes. The back of the bridge is ballasted with cross girders and floor plates. An additional temporary tier of eight bays is erected on top of the back end of the bridge, and is stayed and braced with standard units. Cross girders are placed at intervals along the bridge and at the front end two cross girders and sleepers are carried for forming a suitable grillage on the opposite abutment. A winch is placed in the rear of the bridge and the launching of the structure is effected by means of a snatch block fixed and staked near the first abutment, a sling being fixed to the second cross girder.

After launching, the bridge is lowered by jacks or screws and the cross girders and one row of floor plates are fixed in position to give access to the opposite abutment. End towers are erected from spare material previously used as ballast at the end of the bridge. Snatch blocks are placed at the apex of each tower and ropes with union screws staked on each abutment provide support and adjustment to the centre portion of the bridge while the underslung portion is erected. When the girders are completed the remaining floor plates are fixed and the tower steel work removed.

In the second method the same scheme as the first would be used except that instead of small double-flanged wheels running on flat-bottom rails, standard cross girders secured longitudinally to the suspension plates would be employed, the weight being carried on fixed sleeper grillages through double-flanged rollers and bearings. In this method it would be unnecessary to level the whole length of the bridge approach.

In the third method the bridge would be erected on the approach, with the exception of a portion of the floor plates from the front of the bridge. These would be used as back ballast. A nose of standard units is attached to the bridge. Launching of the underslung tier type would be completed as under the first scheme, using rollers and pins through the lower bobbin holes. After launching, the bridge would require lowering approximately 10ft. on to the abutments. Launching of the through type bridge would be carried out by rollers and brackets secured to the undersides of the cross girders. After launching, the bridge would require lowering approximately 1ft. on to the abutments.




METHODS OF ERECTING STANDARD BRIDGES

# H.M.S. "Hood" and the "Bismarck"

THE story of the pursuit and destruction of the "Bismarck" is best told in the words of the Admiralty communication of Tuesday evening, which reads as follows :—

"Air reconnaissance by Coastal Command aircraft revealed that a German battleship and cruiser which they had previously located in the Norwegian port of Bergen had sailed. Certain dispositions were therefore ordered, and as a result H.M.S. 'Norfolk' (Captain A. J. L. Phillips, R.N.), wearing the flag of Rear-Admiral W. F. Wake-Walker, C.B., O.B.E., and H.M.S. 'Suffolk' (Captain R. M. Ellis, R.N.) were ordered to take up a position in the Denmark Strait.

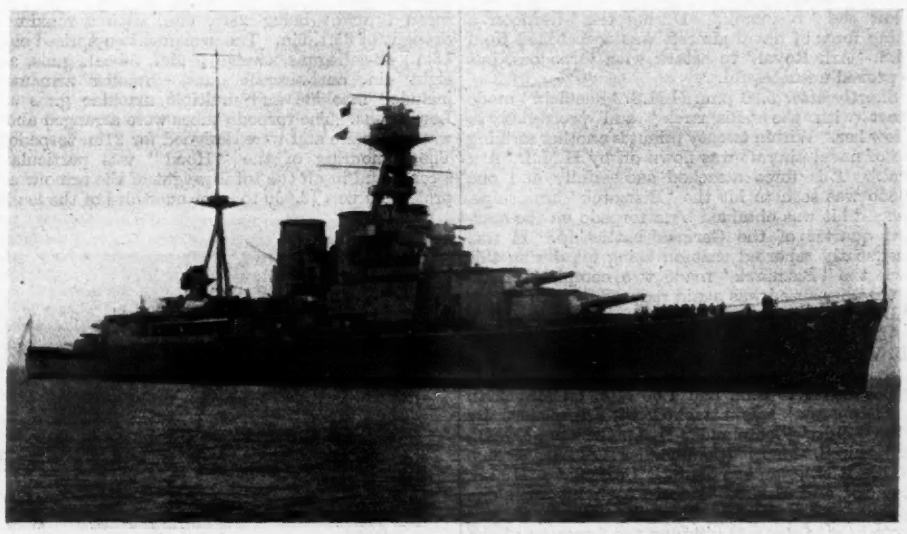
"On the evening of May 23rd Admiral Wake-Walker reported sighting an enemy force of one battleship and one cruiser proceeding at high speed to the south-westward. Visibility in the Denmark Strait was bad and extremely variable. The range of the enemy was only 6 miles when he was first sighted, and storms of snow and sleet and patches of mist at times reduced the visibility to 1 mile. Despite the difficulties of visibility H.M.S. 'Norfolk' and H.M.S. 'Suffolk' shadowed the enemy successfully throughout the night.

"Meanwhile other units of the Royal Navy were taking up dispositions at high speed with a view to intercepting the enemy and bringing him to action with our heavy forces.

"Early in the morning of May 24th H.M.S. 'Hood' (Captain R. Kerr, C.B.E., R.N.), wearing the flag of Vice-Admiral L. E. Holland, C.B., with H.M.S. 'Prince of Wales' (Captain J. C. Leach, M.V.O., R.N.), in company, made contact with the enemy. Action was immediately joined.

"During the ensuing engagement 'Bismarck' received damage, and was at one time seen to be on fire. H.M.S. 'Hood,' as has already been announced, received a hit in the magazine and blew up. H.M.S. 'Prince of Wales' sustained slight damage.

"The chase was continued on a south-westerly course with H.M.S. 'Norfolk' and H.M.S. 'Suffolk' shadowing the enemy and maintaining contact despite all his efforts to shake off the pursuit. It appeared at this time that the enemy speed had been slightly reduced, and reconnaissance aircraft of the



H.M. BATTLE CRUISER "HOOD"

Coastal Command reported that she was leaving a wake of oil.

"On the evening of May 24th H.M.S. 'Prince of Wales' again made contact with the enemy and action was joined for a short time. The German ships at once turned away to the westward and then swung round on to a southerly course, with our forces still in pursuit. Other of our naval forces were now approaching the enemy, and during the night naval torpedo bombing aircraft from H.M.S. 'Victorious' (Captain H. C. Bovell, R.N.) delivered a torpedo attack on the enemy from a considerable distance and one torpedo was seen to hit the 'Bismarck.'

"H.M.S. 'Norfolk,' H.M.S. 'Suffolk' and H.M.S. 'Prince of Wales' continued to shadow the enemy successfully until shortly after 3 a.m. on May 25th. Touch with the enemy was now lost in low visibility. The enemy was then approximately 350 miles south-south-east of the southern point of Greenland. Searching dispositions were at once taken up by other units of the Royal Navy.

"The main body of the Home Fleet under the command of Admiral J. C. Tovey, K.C.B., D.S.O., with his flag flying in H.M.S. 'King George V' (Captain W. R. Patterson, C.V.O., R.N.), was steaming at high speed in a south-westerly direction from northern waters.

"Another force under the command of Vice-Admiral Sir James F. Somerville, K.C.B., D.S.O., with his flag flying in H.M.S. 'Renown' (Captain R. R. McGrigor, R.N.), was steaming north-westwards at high speed from Gibraltar.

"H.M.S. 'Rodney' (Captain F. H. G. Dalrymple Hamilton, R.N.), H.M.S. 'Ramillies' (Captain A. D. Read, R.N.), who were escorting convoys in the North Atlantic, proceeded to move in the direction of the enemy.

"Extensive air searches were organised by Coastal Command and by the Royal Canadian Air Force stationed in Newfoundland.

"It was not until about 10.30 a.m. on May 26th that the enemy was again located. At that time the 'Bismarck' was sighted by a Catalina aircraft of Coastal Command in a position about 550 miles west of Land's End. This aircraft was attacked, and as a result lost touch with the enemy battleship half an hour later, but at 11.15 a.m. the 'Bismarck' was sighted by naval aircraft operating from H.M.S. 'Ark Royal' (Captain L. E. H. Maund, R.N.). Only the battleship 'Bismarck' was seen, and she was then steering an easterly course.

"At this time H.M.S. 'King George V' and H.M.S. 'Rodney' were approaching the area, but were not yet sufficiently close to bring the enemy to action.

"As soon as 'Bismarck' was sighted by 'Ark Royal's' aircraft, Admiral Sir James Somerville detached the cruiser H.M.S. 'Sheffield' (Captain C. A. A. Larcom, R.N.) to make contact with and shadow the 'Bismarck.' During the afternoon a striking force of naval aircraft was despatched from H.M.S. 'Ark Royal' to attack with torpedoes, but this proved unsuccessful.

"Shortly after 5.30 p.m. H.M.S. 'Sheffield' made contact with the 'Bismarck' and proceeded to shadow her. Within twenty minutes another striking force of naval aircraft was flown off by H.M.S. 'Ark Royal.' This force attacked successfully and one torpedo was seen to hit the 'Bismarck' amidships. A second hit was obtained by a torpedo on the starboard quarter of the German battleship. It was subsequently reported that on being hit during this attack the 'Bismarck' made two complete circles and that her speed was again reduced.

"During the evening some of our destroyers of the 'Tribal' class, under the command of Captain P. L. Vian, D.S.O., R.N., in H.M.S. 'Cossack,' made contact soon after 11 p.m.

"Between 1.20 a.m. and 1.50 a.m. on May 27th the 'Bismarck' was attacked with torpedoes by H.M.S. 'Zulu' (Commander H. R. Graham, D.S.O., R.N.), H.M.S. 'Maori' (Commander H. T. Armstrong, D.S.C., R.N.), and H.M.S. 'Cossack.' H.M.S. 'Cossack' and H.M.S. 'Maori' each hit with one torpedo. After H.M.S. 'Maori's' attack it was reported that there was a fire on the forecastle of the German battleship.

"One hour after these attacks by our destroyers it was reported that the 'Bismarck' appeared to be stopped. She was then about 400 miles due west of Brest and had been pursued by our forces for more than 1750 miles. It was subsequently reported that the 'Bismarck' was again under way, and had made good about 8 miles in one hour, and that she was still capable of heavy and accurate gunfire.

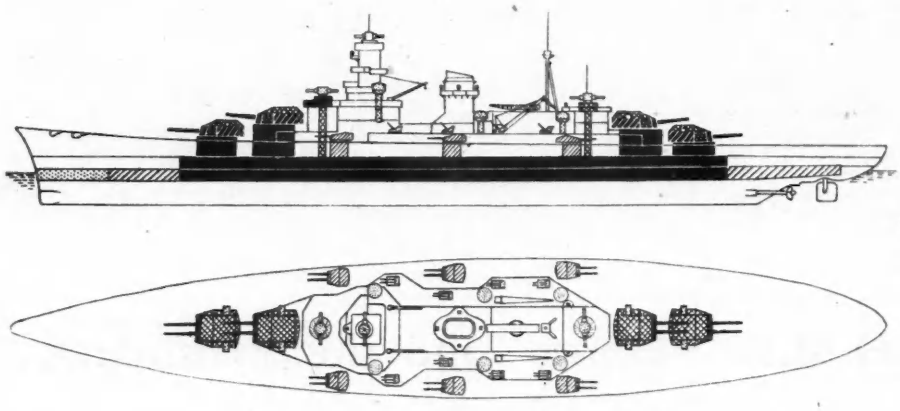
"At daylight on May 27th another striking force of naval aircraft was despatched from H.M.S. 'Ark Royal,' but this attack had to be cancelled owing to low visibility.

"Shortly after daylight the 'Bismarck' engaged our destroyers by gunfire. H.M.S. 'Norfolk' was in action with the 'Bismarck' almost immediately afterwards and very soon the 'Bismarck' was being engaged by our heavy ships.

"Details of this phase of the action have not yet been received. It is known, however, that H.M.S. 'Dorsetshire' (Captain B. C. S. Martin, R.N.) was ordered to sink the 'Bismarck' with torpedoes.

"'Bismarck' sank at 11.01 this morning.

"So far as is known at present the only damage sustained by H.M. ships other than H.M.S. 'Hood' is the slight damage to H.M.S. 'Prince of Wales,' already referred to."



PROFILE AND PLAN OF THE "BISMARCK"

### THE BRITISH BATTLE-CRUISER "HOOD"

The battle-cruiser H.M.S. "Hood," a view of which we reproduce above, was begun in the autumn of 1916 under the Emergency War Programme and was one of four ships, the "Anson" (Armstrong), "Howe" (Cammell Laird), "Rodney" (Fairfield) and "Hood" (John Brown). The original design, which was begun in 1915, was intended to meet the German battle-cruisers which were laid down in 1916, the "Graf Spee," the "Mackensen," the Ersatz "Freya" and the Ersatz "A." When, however, the enemy ceased work on her large ships in 1917, the work on the "Anson," "Howe" and "Rodney" was stopped in the March of that year. It was, however, continued on the "Hood" and she was launched on August 22nd, 1918, having been laid down on September 1st, 1916. She was completed on March 5th, 1920. The design adopted was one which included the lessons learned at Jutland, and particular features were the very large areas covered by heavy armour, the great strength of the framing, and the general protection provided, which included some 5000 extra tons after the design had been finally approved in 1917.

The displacement of the "Hood" was 42,100 tons, or 46,300 tons when fully loaded, the ship's complement of officers and men being about 1341 persons. The principal dimensions were :—Length between perpendiculars, 810ft., length overall, 860ft. 7in., with a beam outside the bulges of 106ft. 2½in., the mean draught being 28ft. 6in., with a maximum draught of 35ft. 6in. The armament comprised eight 15in., 42-cal. guns, twelve 5·5in., 50-cal. guns, and eight 4in. anti-aircraft guns. Smaller armament included machine and multiple machine guns and Lewis guns. The torpedo tubes were arranged above water in pairs and were designed for 21in. torpedoes. The armouring of the "Hood" was particularly strong, and in all the total weight of the armour and protection was 13,000 tons, or one-third of the loaded displacement of the ship. The bulges with which the hull was furnished were of the improved D'Eyncourt-Hopkinson pattern. The vertical side armour had a maximum thickness of 12in. and was made of Krupp cemented steel. Its area at the water line embraced a total length of 562ft. with a depth of 9ft. 6in. Heavy armour covered the barbettes, the turrets, the director and control towers, and the gun shields. The main and lower decks were also covered with high-tensile steel, which had a thickness of 3in. over the main deck and the magazines, and a similar thickness on the crowns of the director and control towers, the torpedo control tower, and the gun turrets. There was also special protective armouring of high-tensile steel over the magazines, engine and boiler-rooms, bulges and buoyancy spaces.

The propelling machinery of the "Hood" was designed and supplied by John Brown and Co., Ltd., and was the forerunner of that used in later high-speed large liners for merchant service. It comprised a quadruple-screw arrangement of Brown-Curtis all-geared turbines which took steam from twenty-four small-tube Yarrow oil-fired boilers. By the adoption of the small-tube boiler it was possible to save weight, and it is recorded that some 24,000 S.H.P. was gained on the same machinery weights as for the "Renown" class of battle-cruiser. The designed output of the machinery of the "Hood" was 144,000 S.H.P., corresponding to a speed of 31 knots. The fuel tanks had a capacity of 1200 tons for normal service, but up to 2000 tons of fuel could be carried if desired.

The total weight of the propelling machinery, with the boilers filled to working level, was 5350 tons. According to unofficial returns quoted by "Jane's Fighting Ships," the trials over the Arran measured mile were particularly successful, and with a displacement of 42,200 tons a total output of 151,000 S.H.P. was developed, corresponding to a speed of 32·07 knots. The trial was made in bad weather with a wind force of 6 Beaufort scale. With an increased displacement of 44,600 tons a mean speed of 31·89 knots was recorded. At a lower output of two-fifths power a speed of 25 knots was easily secured.

The fuel rate was very satisfactory, as the subsequent figures for the world cruise made by the "Hood" showed. At the economical speed of 288 miles in twenty-four hours 180 tons of oil fuel were burned amounting to 7½ tons per hour or 0·625 ton per mile run.

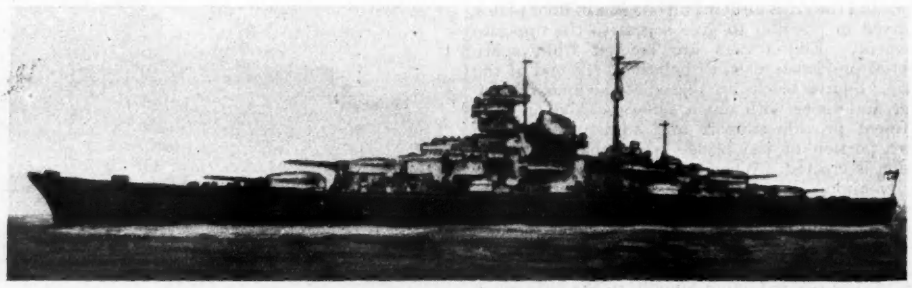
From time to time repairs were carried out principally in connection with routine overhauls, but in 1929 to 1930 the "Hood" was refitted and generally overhauled, and in the following year a catapult was fitted and provision was made for carrying one aircraft on the quarter deck.

### THE GERMAN BATTLESHIP "BISMARCK"

The "Bismarck" was the first of four battleships; the "Tirpitz," said to be approaching completion in the Wilhelmshaven Naval Yard, where a sister ship is also under construction, which will probably bear the name of "Friederich der Grosse," while the other ship is under construction at the Blohm and Voss yard at Hamburg, where the "Bismarck" was built. She was launched on February 14th, 1939, in the presence of Herr Hitler, and it is recorded that after the naming ceremony the hull did not at once move on the ways, and when it left the slips it ran aground. The ship has a standard displacement of 35,000 tons and her principal dimensions are :—Length on water line, 792ft. 4in.; beam, 118ft.; and mean draught, 26ft.

The main armament of the class comprises eight 15in. guns arranged in four turrets, as indicated in the accompanying plan. There are twelve 5·9in. guns grouped in pairs in six other turrets, three on either side amidships. In addition, there are sixteen 4·1in. guns, probably for anti-aircraft protection, but no particulars have been published as to any smaller machine guns or the torpedo armament and arrangement. It is known that provision was made in the design for four aircraft and that two catapults were fitted. There are no official reports concerning the armouring of the ship. Features of the design which will be apparent from our engravings are the overhanging stem and the characteristic cowl on the funnel. There is little known with regard to the propelling machinery of the "Bismarck," which was of the usual geared turbine design with high-pressure oil-fired water-tube boilers. It is said to have been designed for a speed of over 30 knots.

In conclusion we have to acknowledge the per-



THE "BISMARCK" AT SEA

mission of the proprietors of "Jane's Fighting Ships," Sampson Low, Marston and Co., Ltd., to use the accompanying profileand plan drawing and particulars, and Mr. Francis E. McMurtrie, the editor of "Jane," for the use of the photograph of the "Bismarck" at sea.

## American Engineering News

### American Marine Notes

APPROPRIATIONS for naval and mercantile shipbuilding in the United States in 1940 included £25,000,000 for expansion of both Navy and private yards and the construction of new yards. Up to March, in 1941, the amount was £240,000,000, but this was largely for building up a "two-ocean" Navy—for service in the Atlantic and Pacific. With new and extended yards there will be about 200 shipbuilding ways available for merchant marine construction. The productive capacity in 1940 was estimated at one million gross tons of merchant vessels annually. But this will probably not be reached in 1941, owing to many of the ways in private yards being engaged on naval construction. With the enormous development in the steel industry a busy season is expected for the ore carrying fleet on the Great Lakes, conveying iron ore from the head of the lakes to ports on the lower lakes. Nearly 300 large steamers are employed on this service during a navigation season of April or May to near December. The capacity is 72,000,000 gross tons, but the highest record reached was 65,205,000 tons. An interesting development on the lakes was the putting in service of a new car ferry—or train ferry—steamer on Lake Michigan in March. About twenty such steamers are operated by the several railways reaching the lake ports. The new twin-screw steamer "City of Midland" has turbo-generator propulsion and is streamlined in general outline. It is 406ft. long and can carry thirty-four large bogie freight cars on its four tracks, while the upper deck has accommodation for fifty automobiles.—A novel type of small craft is a "one-man" tug or tender for large hydraulic dredgers, used to shift the pipe line pontoons, to supply barges, &c. One of these for service at the Panama Canal is 48ft. long and 12ft. beam, with 5ft. 3in. draught. The screw is driven by a six-cylinder reversible oil engine of 160 H.P., the operation of which is controlled from the pilot house.

### American Motor Locomotives

Among the latest developments in the use of motor or oil-electric locomotives in the United States are the new engines of the Chicago Rock Island and Pacific Railway, which are to handle fast and heavy passenger trains between Chicago and Tucumcari, 875 miles, at which point they connect with the Southern Pacific Railway. Each engine has its frame carried on two six-wheel bogies, and each bogie has an oil engine of 1000 H.P. driving an electric generator which serves four motors geared to the two driving axles, with a single-reduction ratio of 58 to 25. The front end is of the now familiar streamlined type, and the rear end has a vestibule connection to the vestibule of the first car. The entire length is enclosed by a cab, in which the engine compartment is 48ft. long. The two oil engines are turbo-charged six-cylinder vertical four-cycle machines, having cylinders 12½in. by 13in. and running at 740 revolutions. Their bed-plates are of cast aluminium to reduce weight. Each engine drives a direct-connected main generator, an auxiliary generator on the extended shaft, and a split-pole exciter. A special switch on the exciter shaft maintains full load on the engine, independent of such variable conditions as temperature and altitude. The engines are cooled by a current of air from 54in. fans. Two steam generators provide for heating the locomotive and the train. General dimensions are as follows :—

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| Tractive force, starting... ... ... ... ... | 53,000 lb. |
| Driving wheels—four pair, diameter ... ... | 40in. |
| Carrying wheels—two pair, diameter... ... | 40in. |
| Wheel base, bogie... ... ... ... ... ... | 16ft. |
| Wheel base, engine ... ... ... ... ... | 58ft. |
| Weight on driving wheels ... ... ... ... | 110 tons |
| Weight on carrying wheels ... ... ... ... | 55 tons |
| Weight, total in running order ... ... ... | 165 tons |
| Length overall ... ... ... ... ... ... | 75ft. |
| Height overall ... ... ... ... ... ... | 14ft. 6in. |
| Width overall ... ... ... ... ... ... | 10ft. 6in. |
| Width inside ... ... ... ... ... ... ... | 9ft. 9in. |
| Fuel oil ... ... ... ... ... ... ... ... | 1200 gallons |
| Lubricating oil ... ... ... ... ... ... | 160 gallons |
| Driving journals in roller bearings ... ... | 7in. |
| Maximum speed ... ... ... ... ... ... | 120 m.p.h. |

IRON FROM THE PHILIPPINES.—Production at the Paracale Iron Mines, owned by the Agusan Gold Mines Company, continues to expand. Up to the middle of June, 1940, the mine had shipped over 90,000 tons of iron ore, which was nearly as much as it had shipped during the whole year of 1939. It is now producing about 900 tons a day from the mine, as well as shipping an additional 600 tons a day from its stock piles, which are estimated to contain upwards of 50,000 tons. As much as 1,000,000 tons of good grade iron ore, chiefly magnetite and hematite, is said to be in sight. Actual shipments of iron ore to date have checked the estimates of the engineers quite closely as to grade, which during 1939 averaged over 64 per cent. iron and 2·2 per cent. silica.

# Markets, Notes and News

**The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer**

### The General Situation

Now that the Battle of the Atlantic is on, it is only to be expected that the Iron and Steel Control will continue to tighten up its regulations to ensure that as little steel as possible is permitted to pass through into non-essential industries, and the trade must be prepared for drastic changes in the handling of the steel position. That the Control has done good work in keeping our war factories well supplied, and in building up reserves of material as a safeguard against possible interruptions later on, cannot be denied; as a matter of fact, it has so effectively throttled the non-essential consumption of steel that deliveries to priority consumers have in many instances recently been shortened considerably. This applies particularly to heavy structural steel and to the various specialties produced by the rolling works. Shipping and dollar problems influence to a considerable extent the policy adopted by the Control, which it will be remembered has for some time past cut down exports to a minimum. Complaints continue to be uttered by iron and steel masters that they are unable to obtain as much scrap as they would like, and it must be admitted that they do not see altogether eye to eye with the authorities, who take the view that scrap supplies are adequate. No doubt there is an enormous reserve of scrap in the country, much of which has still to be collected from local dumps, and it seems probable that this job is not being tackled in the right way. At the same time, it is obvious that with the production of iron and steel in this country at around record levels, it is no easy matter to keep the industry fully supplied with scrap all the time. In America the steel industry is reported to have resumed full capacity working again, after the recent setback caused by the coal strike. There is now a fresh threat of coalfield trouble, but it is anticipated that the Administration will take a firm line this time. The Roosevelt Administration is, of course, firmly in the political saddle, and there is therefore no fear that it will diverge from its professed policy of building up an immensely strong industrial organisation for defence purposes.

### The Pig Iron Market

In some districts the heavy casting foundries report an increase in Government orders, and as a result their consumption of foundry pig iron is rising. There is little improvement in the light castings market, however, and the general appearance of the foundry pig iron market is rather patchy. Heavy castings are, of course, in demand for the machine tool industry, and this will ensure a regular demand for foundry pig iron in this section for some considerable time to come. The basic pig iron situation also seems satisfactory, despite the heavy demand for this grade. There does not appear to be any surplus, however, as any excess production in one district is absorbed in other parts of the country. In the hematite market conditions remain tight, and as the home production is inadequate to meet the heavy demand, the Control is being compelled to allot certain tonnages from its accumulated stocks of imported hematite. As this latter material is costly and somewhat difficult to bring into the country, it is not being freely released, and every effort is being made by the authorities to ensure that its consumption is essential for the war effort. In these circumstances it is not surprising that many consumers who normally use hematite are making do with alternative materials, and are using refined iron, high-phorphorus iron, and steel scrap in their furnace mixtures. There seems to be a fair amount of high-phosphorus iron in stock, both at furnaces and at foundries. The English and Scottish blast-furnaces appear to be working at or around full capacity, and are likely to continue operating at a high rate of activity.

### The North-East Coast and Yorkshire

The more comfortable supply position of the North-East Coast mills rolling heavy structural shapes seems to have become more marked of late, and this tendency has also extended to other departments. The easier conditions are undoubtedly due to a large extent to the rigid limitation of steel supplies by the Control, as far as non-essential consumers are concerned. It may seem somewhat anomalous at times that the ordinary civilian trade should be kept short of material when the war factories are not able to take the whole of the output, but no doubt the Control is adopting a far-sighted policy. Even should the rolling mills find it necessary to roll for stock to some extent, this is likely to be an advantage, if any setback occurs, either in home production or in arrivals of steel from overseas, since adequate reserves will enable danger periods to be surmounted without undue anxiety. There already exist in this country fair stocks of steel, built up partly from imports from America; but naturally the Control does not wish these reserves reduced to a dangerous extent, and therefore they are only being drawn upon charily. The iron and steel works continue to grumble from time to time about scrap supplies, declaring that they would welcome larger supplies of the particular grades of scrap used. Although it has been officially stated, recently, that scrap supplies arriving at the steel works are adequate, some steel masters regard this view as being on the optimistic side. There is no doubt that the Government would do well to give the scrap situation further attention. Doubtless there is a very large tonnage of scrap in the country at various points, but its economic transport raises special problems of its own. Particularly busy sections of the finished steel market are ship plates, tank and boiler plates, black and galvanised sheets, and special steels. The Yorkshire steel masters report that they are now able to give rather quicker deliveries, partly owing to better transport conditions. The whole district is working at a feverish rate on high-grade and special steels. The forges and rolling mills are intensely busy, and there is an excellent demand for structural steel plates, strip, wire rods, and foundry products.

### Scotland and the North

Despite the difficulties due to war conditions, production of iron and steel in the Scottish industrial area is maintained at an excellent rate. Apart from the makers of light castings, the foundries are busy, but they seem to be obtaining adequate supplies of foundry iron without any particular delay. Hematite pig iron, which is in keen request for steel making, is a tight market, but basic pig iron is reported to be in comparatively free supply. The local blast-furnaces are operating at full capacity. The steel works remain well engaged, and in some directions delivery delays have lessened, owing to the curtailment of allotments to the less essential users. In addition, new priority orders appear to be coming in rather more slowly than previously. In most branches of the industry, however, heavy order books and active conditions are the rule. Owing to the great shipbuilding drive there is an intense demand for plates, not only for hulls, but also for tanks and boilers. A rather better demand is reported for heavy structural steel, which has been a comparatively quiet market for some time past, and there does not seem to have been any relaxation in the buying pressure for light joists. The engineering departments, such as makers of marine and locomotive engines, wagons, &c., are exceedingly busy, and are good buyers of special descriptions of iron and steel. The tube works are well booked, and do not seem to have any spare capacity. Special steels are under particularly heavy pressure, as these are highly important in connection with the manufacture of shells, aircraft, and other war munitions. The wrought iron makers are comparatively well booked, but complain that they cannot obtain enough malleable iron scrap. Re-rolling plants in Scotland are working at a good rate, and future operations are assured for some time ahead, although fresh orders for square bars and small bars have temporarily declined. Black and galvanised sheets of all grades remain in active request, mainly on priority account. In Lancashire the demand for foundry pig iron has again receded slightly, although makers of machine tools are good buyers, and there is a steady demand for forge and special refined pig iron. Bar iron is a rather quieter market, but some grades are somewhat scarce, apparently owing to a shortage of the kind of scrap needed in their manufacture.

### Copper and Tin

There is, of course, no recent information forthcoming as to the volume of output or consumption of metals in Great Britain, but official statements have indicated that the production of war materials is still increasing. An adequate supply of copper is being maintained by the Control for essential Government requirements, but latterly there seems to have been little metal allocated either for export or for ordinary industrial requirements. Whilst one may reasonably expect a larger flow of copper and brass semi-finished and finished products from the United States in the coming months, it is to be anticipated that a somewhat tight supply position will continue. Nevertheless, if supplies of raw copper can be maintained for essential needs as well as has been the case up to the present, the position may be regarded as satisfactory. In the United States supplies remain very short and there is a probability of full Government priorities being instituted in the near future. In view of the enormous quantities of raw copper now available to American consumers, it seems probable that the present tightness is due at least in part to a re-stocking movement on the part of consumers, and somewhat easier conditions may prevail later on. An easier and somewhat dull tone has been apparent in the London tin market recently, due mainly to a Board of Trade announcement that the decision not to issue any export licences for English tin to the United States (or other destinations), is likely to remain in force for a considerable time. As a result prices in London have fallen below New York parity. This is illustrated by the fact that the Government selling price of cash tin, which has been adjusted to New York values daily, is appreciably above the market level here. In the United States, on the other hand, quite active conditions have been seen at times, and a feature has been the purchase by the Navy Department of about 250 tons of tin weekly for the past three weeks. The Metals Reserve Company is unable to operate in the open market owing to the fact that its fixed buying price is well below American market values, but it would appear that the Government there is quite prepared to use other departments for obtaining tin for current requirements.

### Lead and Spelter

Whilst in the aggregate there is a substantial demand for lead, largely in connection with Government requirements, the supply position continues favourable in comparison with certain other metals. Not only is lead readily forthcoming for all essential war purposes, but supplies are also obtainable for the more important industrial uses and also for some export business. A good deal of chemical lead is being used for the construction of works and factories engaged on Government contracts, and the battery and cable makers are working at a high rate. The American situation has changed little and the demand remains well above domestic production, but continues to be satisfied by substantial imports of Mexican lead. In addition to Mexican metal, the United States is also importing lead from South America and even from Australia. . . . The demand for spelter in Great Britain is maintained at a high level and whilst essential requirements have been met in full it is noticeable that for other purposes supplies are difficult to obtain. The position in America is similar to that prevailing here, and some comments by the American Zinc Institute as to the use of spelter in wartime are interesting. In addition to the well-known and substantial use of zinc for brass making, it is used for the manufacture of numerous articles for war purposes, and is required for use in non-ferrous alloys. Zinc die castings, large and small, are essential elements in the assembly of aerial cameras, radio and signal equipment.

# Notes and Memoranda

## Rail and Road

TRANS-SAHARAN RAILWAY.—It has been reported that work upon the construction of the 1000 desert miles of the Trans-Saharan Railway has been begun, and that 3000 H.P. oil-engined locomotives will be used for the haulage of what will mainly be goods traffic.

THE PIT RIVER BRIDGE.—What is said to be the highest double-deck span in the world is the Pit River bridge in the Central Valley of California, carrying traffic between San Francisco and Portland, Oregon. According to *Engineering and Contract Record*, the upper deck of the bridge will be 500ft. above the level of the Pit River and will carry four lanes of U.S. Highway 99.

RAILWAY TAXATION.—Among other proposed new taxes, the U.S. Treasury has under consideration a 5 per cent. tax on amounts paid for passenger transportation. The estimated annual yield from such a tax is put at 37,600,000 dollars. Another proposal is that involving an increase of 1 cent (from 1½ to 2½ cents) per gallon in federal excise tax on gasoline. The estimated yield from that was put at 255,000,000 dollars.

BEYER-GARRATT LOCOMOTIVES.—At the recent annual meeting of Beyer, Peacock and Co., Ltd., the chairman, Captain Hugh Vivian, referred to the principal new design of Beyer-Garratt locomotives constructed during the past year. Four of these engines, which are of a semi-streamlined type, having a 4-6-4+4-6-4 wheel arrangement, were shipped to Rhodesia and have already completed 250,000 miles in service on passenger and goods trains between Bulawayo and Salisbury.

TOO MUCH NOISE.—Our contemporary, *Indian Engineering*, prints a letter sent to a railway company by a man who had the misfortune to live near a large junction. Here is his protest:—"Why must your engines ding and dong and bang and fizz and spit and pant and grate and grind and puff and bump and chug and hoot and toot and whistle and wheeze and jar and jerk and snarl and slam and throb and roar and rattle and yell and smell and smoke and shriek and scream all the night long?"

AMERICAN TANKS.—The United States Army has taken delivery of the first of 685 medium (M-3) combat tanks ordered on November 23rd, 1940, from the American Locomotive Company, of Schenectady, N.Y. The tank has an overall length of 18ft., is over 8ft. in height, and weighs about 28 tons. It is made up of more than 14,000 parts, is armed with machine guns and 75 mm. and 37 mm. cannon. Before the work could be begun more than 200 new machine tools had to be ordered, received and installed, and existing machine tools had to be rearranged. Over 2500 different drawings had also to be made.

CABLEWAYS IN EAST AFRICA.—Among the engineering work initiated by Mussolini in East Africa are cableways for the transport of goods. The most important (perhaps the longest yet constructed anywhere) is that between Massawa and Asmara, 44·6 miles, with a 2-mile branch from Zaga, the first station out, to a stores depot at Moncullo. The "rolling stock" comprises 1500 trucks, each capable of carrying 300 kilos., running 100 m. apart, and taking 7 hours to make the entire run, as the cable speed is, say, 9ft. per second. About 300 tonnes could be carried each way in a working day if all trucks were fully loaded.

DECLINING TRAFFIC IN AMERICA.—In the course of a paper read before the Western Conference of Railway Counsel, Mr. Samuel O. Dunn told his hearers that increased competition and the impact of the depression had reduced railway gross earnings to less than two-thirds as much during the decade ending with 1940 as they were during the decade ending with 1930. Railway managements had made the most drastic retrenchments in history, but the 1932 wage reduction was rescinded and wage advances were made in 1937 to the highest levels in history, and have since been kept in effect, while taxation had increased.

L.M.S. ENGINE, "KING GEORGE VI."—The L.M.S. Railway announces that one of its new "Coronation" class streamlined locomotives is, by Royal permission, to be named "King George VI." The "Coronation" class engines are the heaviest express passenger locomotives on the L.M.S. The original "Coronation" engine—the first streamlined locomotive to be built by the company—and so named to commemorate the coronation of the present King and Queen, was exhibited at the New York World's Fair. Prior to going on exhibition it made a 3000 miles tour of the principal American cities, and was visited by nearly two million people.

## Air and Water

LENINGRAD HARBOUR.—A recent Moscow message states that the harbour of Leningrad will soon be available again for the use of shipping.

TRANS-TASMAN AIR SERVICE.—The Trans-Tasman air service has recently completed its first year of operation, during which 1500 passengers and more than 75,000 lb. of mail have been carried between Auckland and Sydney.

ALEXANDRETTA HARBOUR.—Reports from Ankara state that arrangements are proceeding for the modernisation of the harbour of Alexandretta. It seems that Alexandretta is likely in the future to be the main port of Turkey for trade with Great Britain.

PRESERVED ICE FLAKES.—Mr. V. T. Schaefer, of the research laboratories of the General Electric Company of Schenectady, N.Y., has devised a method for preserving permanently the crystal beauty of snow flakes. By covering a snow flake with a drop of a solution of Formvar, a transparent plastic resin often used for electric insulation, and allowing the drop to dry, Mr. Schaefer found, a permanent cast of the snow-flake crystal can be obtained. Though the film remaining is only about 0·00008in. in thickness, it preserves the characteristic hexagonal snow-flake features in the most microscopic detail for later photographing or microscopic study. No two snow-flake crystals are ever exactly alike.

NEW AIR MAIL ROUTE.—The Postmaster-General has announced that air mail correspondence for Burma, Ceylon, Dutch East Indies, India, Malaya and Thailand (Siam) may now be sent throughout by air by way of the United States as an alternative to the existing route, which is by sea as far as South Africa.

AMERICAN SHIPBUILDING.—The latest list issued by the American Bureau of Shipping states that on April 1st the total number of ships on order or under construction in American shipyards was 542, of 3,029,325 gross tons. These figures, says the *Journal of Commerce*, compare with 327 of 1,690,328 gross tons on March 1st.

ALL-INDIA RADIO.—Under a scheme which is now well advanced, a powerful receiving station for the All-India Radio is to be installed at Lucknow. The apparatus has arrived, and is already under test. The powerful receiving station will pick up and relay all news bulletins and various interesting programmes of the All-India Radio and the British Broadcasting Corporation.

TURBINE HISTORY.—No fewer than thirteen different early turbines, showing stages in the development of this type of machine, are now displayed in the collection of the Iowa Institute of Hydraulic Research, Iowa City, Iowa. The collection was made by the late Professor Floyd A. Nagler, the director of research from 1931 to 1933. With one exception, all the wheels are of the American or mixed-flow type. The earliest is a Wynkoop water wheel patented in 1866.

WATER FOR CALCUTTA.—A proposal to put down tube wells in and around Calcutta is now likely to mature. It was first mooted as a supplementary measure for fresh water supplies during the hot weather, but the high cost proved an obstacle, especially as it was only during a brief period that the contingency of fresh water scarcity arose. The war, however, has hastened a decision, and the installation of about 3000 tube wells at a cost of Rs. 21,00,000 at different places in the city has been decided between the Government of Bengal and representatives of the Corporation of Calcutta.

LAUNCH OF THE "SOLON TURMAN."—The fourth of five ships being built at the Sparrows Point yard of the Bethlehem Steel Company for Lykes Brothers Steamship Company was recently launched and was named the "Solon Turman." This ship, which is of the Maritime Commission's "C-1B" type, will have a deadweight capacity of 9075 tons, a displacement of 12,875 tons, and a cargo carrying capacity of 7786 tons with accommodation for eight passengers. The propelling machinery will consist of a 4000 H.P. cross-compound double-reduction geared turbine designed to give an average sea-going speed of 14 knots.

NEW MOTOR LIFEBOAT.—A new motor lifeboat has arrived at Cadgwith, Cornwall, and has replaced the pulling and sailing lifeboat. She is the "Guide of Dunkirk," and has been built out of a gift of £5000 from the Girl Guides of the Empire. She had just been completed in a building yard on the East Coast at the end of May, 1940, and was one of the nineteen lifeboats of the Royal National Lifeboat Institution which helped to bring off the B.E.F. from Dunkirk. She is a light self-righting lifeboat of a new type, 35ft. 6in. long. She weighs 6¾ tons before launching, and is fitted with tanks which automatically fill with half a ton of water as soon as she is afloat. This water ballast makes her more stable, and also helps to bring her right way up if she should capsize. She has a 35 H.P. engine, and a speed of over 7 knots.

DELAWARE RIVER BRIDGE.—The opening of two additional lanes on the Delaware River bridge, between Camden, N.J., and Philadelphia, Pa., has been proposed to relieve traffic congestion caused by increasing use of the span, which was indicated by a record total of 14,185,835 vehicles having crossed the structure during 1940. This figure represents an increase of 807,600 over 1939. The construction of two 14ft. lanes in spaces originally provided for trolley tracks would cost approximately 1,000,000 dollars. *Engineering News-Record* states that the two additional lanes would be of considerable value in relieving the traffic congestion, although the undertaking would not solve the problem until wider approaches on both the New Jersey and Pennsylvania sides are made. Inadequacy of the approaches was emphasised in a recent report by the Delaware River Joint Commission.

## Miscellanea

WELDING GLASS.—An American concern claims to have succeeded in using high-frequency electric energy for welding glass.

JAPAN SHORT OF NICKEL.—The Japanese Ministry of Commerce and Industry has imposed restrictions on the use of nickel and nickel alloys, owing to reduced imports of the metal from Canada and Norway. Mercury also is in short supply. Export permits have been freely granted to England and Canada, but a recent application for a permit to export American mercury to Japan has been turned down.

"SOUR GAS."—What exactly is meant by this term is not clearly defined in a report that the Arkansas Power and Light Company has asked the Federal Power Commission for permission to launch immediately a six-year power development programme representing an investment of more than 10,000,000 dollars to speed industrial development in its territory. Since the power company recently stated that its ability to use "sour gas" as a fuel for power generation would depend on some other large industry in the territory utilising the by-products obtained in sweetening the gas, it is presumed that the utility has succeeded in obtaining such an industry for South Arkansas.

COPPER IN SWEDEN.—Trial drillings in the Skellefte district of Sweden have revealed copper ore deposits at a depth of 250 m. to 300 m. The mine is expected to yield about 750,000 metric tons of copper ore. About 200,000 tons of ore with a copper content of 2 per cent. has been mined about 100 yards north of this deposit. Investigations made in the Svappevaare district, in the province of Norrbotten, also reveal some copper ore.

IRON IN INDIA.—The publication of a paper prepared by Dr. J. A. Dunn, of the Geological Society of India, has directed attention to certain aspects of the formation and sequence of a group of rock strata known as the iron ore series in the South Singhbhum area in Bihar. The upper or Kolham series comprises shales on top, limestones in the middle, and sandstone conglomerates in the base, which rest uncomfortably on the lower or real iron ore series.

GOLD IN MYSORE.—What promises to be a large and rich find of alluvial gold has been reported. While conducting trial washings in the Palavanhalli area, a small rolled boulder of gold-bearing quartz was found near Ganjiganhalli. This boulder, weighing about 9 lb., shows rich streaks and coarse particles of gold, and it has been estimated—by specific gravity determinations—that it contains in the aggregate gold to the value of Rs. 4500 at the present market price.

MACHINE TOOLS FROM INDIA.—The Mysore Government has sanctioned the establishment of a factory for manufacturing machine tools at Harihar. It will be a joint stock company registered in the State with an authorised capital of Rs. 10 lakhs, of which Rs. 5 lakhs are to be issued at present. It is to be worked by Kirloskar Brothers, Ltd., as managing agents, who are to have an office allowance of Rs. 6000 per annum. For its supply of pig iron and steel, the company will draw on the Mysore Iron and Steel Works.

THE NEWCOMEN SOCIETY.—This year, owing to restrictions of all kinds, the Council has decided to limit summer activities to a day's excursion by coach, on Friday, June 13th. Visits will be made to Nap Hill to see the workshop of Mr. E. H. Goodchild, where Windsor chairs are made; then to Turville Heath, *viâ* West Wycombe and Fingest to see "bodger" chair-leg making, by kind invitation of Mr. Samuel Rockall; and thence to Stokenchurch to visit the factory of Messrs. Dean and Sons to see chair-making on a small factory scale.

## Personal and Business

MR. J. W. RODGER, chief engineer of Bruce Peebles and Co., Ltd., has been elected a director of the company.

MR. L. W. HOLT has been appointed a director of Elder Dempster Lines Holdings in place of the late Sir Richard D. Holt.

MR. H. GERRISH SMITH has been re-elected President, and Mr. Roger Williams Vice-President, of the National Council of American Shipbuilders.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., informs us that the address of its Manchester branch is now 15, Quay Street, Deansgate, Manchester, 3.

THE Mersey Docks and Harbour Board has announced that Mr. R. J. Hodges will succeed Sir Lionel A. P. Warner, who will shortly retire from the position of General Manager and Secretary.

THE Iron Trades Employers' Insurance Association, Ltd., announces that Mr. J. Reid-Young, C.A., F.C.I.S., director of Vickers, Ltd., and associated companies, has joined its board.

THE Great Western Railway announces that Mr. C. B. Collett will shortly retire from the position of chief mechanical engineer, and that he will be succeeded by Mr. F. W. Hawksworth.

THE Council of the Royal Society of Arts, with the approval of their President, H.R.H. the Duke of Connaught, has decided to confer on his Excellency Franklin Delano Roosevelt, President of the United States of America, the Albert Gold Medal of the Society in recognition of his pre-eminent services to humanity as the fearless and resolute champion of the ideals of national freedom and individual liberty.

MR. G. COLE DEACON, Secretary to the Railway Companies' Association, having been appointed Secretary to the Railway Executive Committee, under an Order of the Minister of Transport dated September 1st, 1939, the Association have appointed Mr. H. A. Chapman to be acting Secretary. All communications should now be addressed to the Acting Secretary, Railway Companies' Association, 4, Cowley Street, Westminster, S.W.1. Telephone, Whitehall 1502.

## Forthcoming Engagements

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

**Incorporated Municipal Electrical Association**

*Thursday, June 12th.*—Clifton Picture House, Clifton, York. General meeting. 11 a.m.

**Institution of Electrical Engineers**

*Friday, June 6th.*—METER AND INSTRUMENT SECTION: Waldorf Hotel, Aldwych, W.C.2. Informal luncheon. 12.40 for 1 p.m.